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CONTENTS

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DISEASE CARRIERS[1]

THE past two decades have witnessed many notable achievements in medicine, chief among which, as regards the infectious diseases, stand the discovery of the curative sera, and the more recent discovery of specific chemical agents for the treatment and cure of disease. The real, ultimate goal toward which the research work bearing on human and animal infections points is, and must be, the cure of the afflicted. No royal road leads to the desired end, but instead numberless trails must be blazed which too often lead seemingly to nowhere. While the crowning achievement, the direct conquest of disease, is the aim, the investigator from the beginning has endeavored to accomplish essentially the same result by preventive means. The search for the cause of disease, the recognition of the portals of entry and exit, the perfecting of methods of disinfection, and the development of preventive inoculation served to build up a fairly effective basis for prophylaxis. These methods would, indeed, have sufficed had the earlier views regarding the spread of disease been correct. The general knowledge regarding the highly contagious diseases made it seem probable that all infections were spread, more or less directly, from the sick to the healthy, and as a result preventive measures were applied to the patient and to his immediate surroundings. The outcome, however, was not always satisfactory and the reason is not difficult to see. Fully as

[1] Address of the vice-president and chairman of Section K, American Association for the Advancement of Science, December 29, 1911.

important as a knowledge of the germ itself is the fundamental fact that disease may be conveyed through the agency of apparently healthy insects, lower animals, and even man himself. It is the recognition of this fact, the existence of *disease carriers,* which has brought about such remarkable results in the fight against malaria, yellow fever, Malta fever and many other diseases. Hence a brief outline of our knowledge of this interesting subject may not be out of place.

It may be well at the outset to state that the term "disease carrier" is applied to animals or persons who, though apparently in perfect health, harbor and eliminate a given disease germ. The fact that the "carrier" is an apparently healthy animal means that the disease may be spread through a wholly unexpected source. The old view of the transmission of disease by contact with the sick remains true, but it is enlarged and supplemented by newer facts. Since more or less direct contact with the apparently healthy carrier, or with the actually sick serves to spread an infection, it is clear that preventive measures must consider the former as well as the latter.

Strange as it may seem, the existence of certain carriers, though not their import, was recognized in the early days of bacteriology. Thus, the presence of the microbe of sputum septicemia in the mouths of healthy persons was noted independently by Sternberg and by Pasteur, in 1880, but it was not until several years later that this organism was shown to be the cause of lobar pneumonia. The frequent persistence of this organism in the sputum after recovery was observed at an early date.

An even more striking example was furnished with the discovery of the diphtheria bacillus in 1883, for Loeffler not only found this organism in the sick, but also in some perfectly healthy children. So contradictory to the accepted order of things was this fact that for several years it prevented the full recognition of this germ as the cause of the disease. The more thoroughly this disease was studied, the more it became evident that recovery did not mean an immediate disappearance of the pathogenic microbe. In other words, clinical recovery did not assure freedom from danger to others. The early recognition of this fact led to the establishment of the bacteriologic control of the recovered patient in the form as it now exists in practise. Two or more consecutive examinations of the throat and nose must yield negative findings before it can be said that the danger of spreading the infection has been overcome.

The presence of the pathogenic agent in the active stage of the disease is a necessary condition; the persistence of such agent during convalescence is more or less to be expected, but the continued existence, at times, of the organism in the individual after complete recovery, and its presence in persons who apparently have never had the disease is somewhat difficult of explanation. The three types thus alluded to are conveniently designated as (1) *convalescent,* (2) *chronic* and (3) *healthy carriers.* The latter in the majority of cases perhaps includes individuals who, at some time, and unknown to them, have had an attack of the disease; they are therefore virtually chronic carriers. Others, though healthy, may be in the incubation stage and hence develop the disease some days later. Lastly, a third group would include strictly healthy carriers, those who have never had the disease and are only remotely liable to it. Obviously, then, it is difficult to distinguish between these several groups of healthy carriers.

DIPHTHERIA

As regards diphtheria, investigations have shown that the healthy carriers are never found in regions free from the disease. They are met with only in places where the disease prevails; the home, hospital, asylum, school and, naturally, the large city furnish examples, though in extremely variable number. Intimate association with the patient, either before or during sickness, as is likely to occur in the home, yields the largest percentage of such carriers. This is especially true where preventive measures, such as isolation and disinfection, are not enforced at the outset. Under such conditions it has been found that fully one third of the exposed become carriers for a greater or less length of time. Where proper measures are instituted early, the number is necessarily greatly reduced. Systematic examinations made in the large cities have, time and again, demonstrated the presence of healthy carriers in from 2 to 4 per cent. or more of the persons tested.

The persistence of the organism in the healthy carrier is usually, and fortunately, of short duration, though exceptionally it may continue to be present for months. Such carriers are unquestionably a source of danger to others and serve to explain outbreaks of the disease where contact with a sick person is positively excluded. The fact that the blood of a majority of the healthy carriers possesses antitoxic properties indicates clearly that they have passed through a previous, though unrecognized, mild infection and consequently that they really belong to the type of chronic carriers. A small number of the healthy carriers may eventually themselves develop the disease, while others, for some unknown reason, escape infection.

The convalescent and chronic carriers are properly looked upon as being dangerous to the community. It is a well-recognized fact that the diphtheria bacillus persists in the throat and nose, for a variable period of time, after the disappearance of all clinical symptoms of the disease. It may remain present for a few days, weeks or months. Fortunately, the vast majority rid themselves of the invading organism in a relatively short time, but as long as they harbor the organism they are in a position to infect others. Isolation, under such conditions, is just as necessary as in the acute stage of the infection. The really chronic carrier, the one who harbors the germs for months, if not years, presents the most difficult problem.

TYPHOID FEVER

The studies on typhoid fever during the past few years have been especially fruitful in enlarging our knowledge of human carriers and have served to concentrate attention to the important part played by these in the propagation of the disease. The accepted cause, the typhoid bacillus, is known to be present not only in the intestines, but also in the internal organs and in the blood. Because of the latter occurrence the majority of typhoid patients, after about the twelfth day of the disease, eliminate the typhoid bacillus in the urine, at times in enormous numbers, and such elimination may continue for weeks after complete recovery has taken place. Exceptionally, the typhoid bacillus may persist in the urine or discharges for months, and years, if not through the remainder of life.

The problem of the healthy carrier is one of special import. Here, as before, we have those who have undoubtedly passed through a previous mild and unrecognized attack of the disease and hence are of the type of true chronic carriers; as such, they are to be looked upon as particularly dangerous. Others there are who but temporarily carry the organism, which soon disappears from the intestine if the source of supply, such as contaminated milk or water, is withdrawn. In these the natural resistance, whatever that may be, is such as to prevent the organism from gaining a foothold and consequently it is soon got rid of. The individual is and remains healthy, and, because of the temporary presence of the organism, is of relatively little danger to others. On the other hand, the healthy carrier may turn out to be in the incubational stage of the disease, the first symptom of which may appear in several days, or two or three weeks after the detection of the bacillus.

During convalescence from typhoid fever, presumably because of persisting lesions, the specific organism continues to be eliminated for some time. In general, however, after the tenth day following the disappearance of the fever, the typhoid bacillus disappears from the excretions of the convalescents, except from about 10 per cent. Most of the latter clear up in from three to four weeks, while others become true chronic carriers.

The chronic bacillus carrier is of especial importance, since to such, more than any other, must be ascribed the persistence of the disease in sporadic form in communities where every precaution is taken to insure a pure water-supply. This fact was most clearly established by the investigations carried on in 1902 in Alsace and Lorraine, where typhoid fever was notoriously in evidence in spite of the utmost effort to control the disease by the ordinary sanitary methods. The conclusions arrived at in the course of those studies have been verified and extended by workers in all parts of the world. The occurrence of typhoid and para-typhoid bacilli in healthy and chronic carriers can hardly be advanced as an argument against the accepted pathogenic rôle of these organisms. The lesson taught by the history of yellow fever and hog cholera might lead us to believe that the above-mentioned organisms were accidental and not causative, and that the real cause might be of an ultra-microscopic character. No experimental evidence, however, has yet been presented in support of this idea. On the contrary, all the known facts, especially the serum reactions, and above all, the remarkable results obtained in the prevention of typhoid fever by inoculation of the dead bacillus point to the etiologic significance of the typhoid germ.

The number of chronic typhoid carriers is not large, being placed by various workers at from 2 to 3 to 5 per cent.; figures which can not be considered as exact in view of the known imperfections of the methods employed. This low percentage, however, is an encouraging and redeeming feature when one considers that the excretion of the typhoid bacillus by such carriers is not always limited to weeks or months, but may continue for years and perhaps till death. This remarkable persistence of the germ is commonly considered to be due to its localization in, and adaptation to the biliary passages. Its presence in the bile and in biliary calculi is an established fact. Usually, with the bile the organism passes into the intestine to be eliminated with the discharges; less often it enters the circulation and appears in the urine. The fact that the bile is a common avenue of elimination when organisms are introduced into the blood may lead one to suppose that the bacillus is primarily localized elsewhere than in the bile bladder, and such a supposition is not without analogy. A vegetative focus within an organ not only explains the presence of the bacillus in the bile and, at times, in the urine, but also accounts for the fact that in others the elimination is of an intermittent character.

The result of studies on the age and sex distribution of carriers indicates that children are the least, while women are most prone to this condition. The latter fact is noteworthy, since the spread of typhoid fever by carriers engaged in the handling of and preparation of food must be considered as beyond question. The figures which we have showing the relative frequency of infection through such carriers vary considerably, owing to the necessarily different conditions prevailing in different regions. Generally speaking, from 4 to 30 per cent. of the cases of typhoid fever are traceable to the chronic carrier. In localized outbreaks, such as arise in the family, the boarding house, and the like, practically every case may have this origin.

Essentially the same facts which have been developed in connection with diphtheria and typhoid fever hold true for other diseases, such as influenza, meningitis, pneumonic plague, dysentery and cholera. In the matter of cholera it may not be without interest to note that one of the most effective means employed during the past summer to prevent the introduction of cholera into this country was the systematic examination of all third-class passengers coming from infected ports for cholera carriers.

By far the most interesting and instructive example of a disease carrier is that revealed in connection with Malta fever. The cause of this disease, the *Micrococcus melitensis*, has been known for twenty-five years, but the real mode of transmission of the disease was not recognized until five years ago. It was then shown for the first time, and quite accidentally, that the goat is really a chronic carrier of the disease organism. The studies of the British Commission showed that among the many thousand of goats examined on the Island of Malta, fully 50 per cent. gave the agglutination test, while 10 per cent. were actually secreting the micrococcus in their milk. The existence of the disease among goats was wholly unexpected, but its existence forcibly taught a lesson on the importance of the chronic carrier.

The disease in the goat was so mild as to pass unnoticed. On recovery, however, the specific germ instead of disappearing became localized in the mammary gland and hence appeared in the milk. The use of this milk by man led to his infection with Malta fever. The recognition that this disease was a milk infection enabled the authorities, once and for all, to put an end to the tribute paid by the British army and navy. The simplest precaution, the boiling of the goat's milk or its avoidance, was sufficient to put an end to the scourge.

In many ways Malta fever in man presents a striking analogy to typhoid fever. In both diseases the specific organism persists in the body during convalescence and indeed after full recovery. Their continued elimination in the urine and discharges indicates a localization in some part of the body. In both infection occurs by way of the alimentary tract.

Carriers are by no means restricted to the bacterial diseases, of which but a few have been discussed. They play an even more important part in the propagation of certain protozoal infections. They constitute the natural reservoirs of virus and, as such, are chiefly responsible for the continued existence of these diseases. Thus, cattle which have recovered from Texas fever do not show, on microscopical examination of their blood, any evidence of the presence of the parasite, and yet such blood injected into a healthy animal gives rise to the typical disease. The parasite is clearly present, either in extremely small numbers, or, what is more likely, in an unrecognizable form in the immune animal. The condition is analogous to that observed in the chronic carriers of typhoid fever and other bacterial diseases; it implies that a reciprocal immunity has been established, an armed truce so to speak, between the host and invader.

In trypanosomal disease chronic carriers are equally in evidence. When recovery occurs, as it does in some animals, the organism, though present in the blood, is practically unrecognizable by means other than inoculation of animals or by artificial cultivation. The culture method had revealed the presence of such trypanosomes in a large percentage of birds, and more recently the same procedure has demonstrated the existence of similar parasites in the cattle of various countries.

The disease caused by sub-microscopic or invisible organisms may show this same persistence of the infective agent long after recovery has taken place. A striking example of this fact has but recently been determined in connection with infantile paralysis where the virus has been found to persist in the naso-pharynx for many months. The existence of the chronic carrier being recognized, it is no longer surprising to learn of sudden outbreaks of this dangerous disease, apparently spontaneous in character, in a locality where no previous case was known to exist.

INVERTEBRATE CARRIERS

Important as the vertebrate carrier may be, it is quite overshadowed by the enormous importance of the invertebrate carrier. It may be asserted without fear of contradiction that the most valuable results which have been accomplished in preventive medicine in recent years have come from the recognition of the exclusive rôle played by these carriers in the transmission of many diseases. Texas fever, malaria, yellow fever, sleeping sickness, not to mention a score of other infections, find their natural transmission in the agency of insects, ticks and other sanguivorous organisms.

It has been customary for some years to speak of insects as *passive* and as *active carriers*, which terms convey certain well-defined conceptions. The passive carrier is an accidental conveyer rather than a natural host for the germ. A fly feeding upon typhoid excreta may soil its feet or proboscis and on alighting elsewhere may deposit such mechanically adhering particles. The part played by the passive carrier is merely one of indirect contamination—a purely mechanical transmission of the infective agent from one place to another. This transference of disease organisms to articles of food, or even into wounds by flying insects may lead to infection, and, in fact, it is generally recognized that certain bacterial and even protozoal diseases may thus be spread. Cholera, dysentery, tuberculosis and typhoid fever are most often mentioned in this connection.

The active carrier, on the other hand, is essentially a diseased individual and corresponds in a way to the chronic vertebrate carrier already discussed. Some, however, can be compared more correctly to the healthy carriers. The insect, tick, leech, and the like, which feed upon an infected animal may become a suitable soil for the disease organism, which either multiplies directly, or else passes through a developmental cycle in its new host. It has been supposed by some that active carriers can harbor only animal parasites, such as the pathogenic protozoa and filaria, an assumption which is quite erroneous. It is undoubtedly true that many of the known active carriers do transmit animal parasites, but that fact is not sufficient to exclude a like transmission of bacteria, nor does it justify the assumption, so freely resorted to, that an unseen and unrecognizable germ which is transmitted by an active carrier is *ipso facto* a protozoon.

The best example of an insect bacillus carrier is seen in bubonic plague, which is spread almost wholly by the bites of fleas which come from naturally infected rats or other rodents. The plague bacillus is present in the blood of the diseased animal, usually some hours before death, and the flea which sucks up such blood into its stomach becomes infected with a variable number of the organisms. These then undergo multiplication in the digestive tube, and persist therein for four to ten to twenty-one days, depending upon the temperature, method of feeding, and perhaps on factors inherent in the flea itself. There is no evidence that the flea is affected in any way by the presence of the bacillus, which leaves the body chiefly, if not entirely, along with the feces. The contact of this excretal matter with the wound is perhaps the chief means by which infection occurs. It is clear, therefore, that the flea is not a mere passive carrier, but an actual host (a healthy carrier), even though the parasite is unable to maintain a very prolonged existence within its digestive tube.

The common rat flea is also one of the agents which brings about the transmission of a protozoal disease among rats, namely, *Trypanosoma Lewisi.* Opinions have differed as to the part played by the flea in the transmission of this infection; as to whether it was a mere passive, or a real active carrier. But recent studies have shown clearly that passive transmission, in this as in other trypanosomatic diseases, though possible, is of no special consequence; and, that the flea is a true host, an active carrier. The work of Minchin and Thomson indicates the existence of an intracellular multiplication of the parasite in the epithelial cells of the mid-gut, as a result of which the trypanosome breaks up into a number, possibly eight, daughter trypanosomes, which then become free and undergo further development and multiplication. The period of incubation is six to seven days or more, but the insect once infected remains so for an indefinite period. Regurgitation of the ripe infective form from the stomach of the flea into the wound made by the proboscis of the flea is, according to these investigators, the normal method of transmission.

Incidentally it may be stated that evidence has been presented, though it can not be said to be conclusive, which goes to show that the dog flea is responsible for the spread of the disease known as infantile kala-azar. Further investigation is needed to determine the mode of transmission of this deadly infection.

The tick family is an extremely important group as regards the transmission of disease of man and animals. The infective agent may be a bacillus, a spirochete; or a typical protozoon such as a piroplasm or a trypanosome. For example, we know from the splendid studies of Ricketts on the so-called Rocky Mountain fever, also known as "spotted" or "tick" fever, that this disease is due in all probability to a bacillus, and, furthermore, that this is invariably transmitted by the bite of a tick, or of its offspring.

The spirochetes which many workers, following the lead of Schaudinn, believed to be protozoa are now rarely classed as such even by zoologists. Instead, they have either been turned back among the spiral bacteria, or have been given a separate position, intermediate between them and the protozoa. This fact is of interest because most of the spirochetal diseases are transmitted through the agency of active carriers, such as the louse and especially ticks. The best example of the latter type of infection is the African tick fever, which is closely identified with the ordinary relapsing fever. The active carrier in this case is the tick, *Ornithodorus moubata,* which not only can transmit the disease directly, but can also do so through its offspring. A spirochetal disease of chicken is similarly transmitted by another tick, *Argas miniatus.*

Our knowledge regarding the change which the spirochete undergoes in the tick and in the egg is by no means complete. Thus, while some workers, such as Koch, described the presence of the spiral organism in the internal organs and in the eggs, other observers have failed to demonstrate their presence. Leishman, a most careful worker, was, as a rule, unable to detect recognizable spirochetes later than the tenth day after ingestion by the ticks. Instead he observed clumps of chromatin granules which were also invariably present in the eggs, larvæ and nymphs derived from infected ticks. The spirochete origin of these granules is uncertain, especially since similar granules were found in nymphs derived from ticks fed on normal blood.

The infection of a healthy animal by a tick may occur, either by the injection of spirochetes with the salivary secretion, or by regurgitation of infective material from the gut, but neither of these modes of infection can be considered as common. Instead, it appears from the work of Leishman and of Hindle, that infection is the result of excretion of infective material from the Malpighian tubules and gut, which enters the open wound caused by the tick's bite. This contaminative wound infection is therefore similar to that already noted in connection with the flea and bubonic plague.

The Texas fever of cattle, as is well known, was the first disease in which transmission through the agency of an insect or arthropod was demonstrated. The facts presented by Smith and Kilborne twenty years ago hold to-day. Thanks to that work which served to open up the entire field of invertebrate carriers, we know that the disease is not transferred directly by the tick which has fed upon an infected animal, but indirectly through the young ticks which hatch from its eggs. The pathogenic agent in this case is a typical intracellular protozoon, the *Piroplasma.* Similar piroplasmatic diseases are met with in a variety of domestic animals and, in all such cases, transmission is effected by ticks at one stage or another of their development.

In addition to the foregoing types of organisms which are transmitted by ticks, passing mention may be made of the common trypanosome infection of cattle, already referred to, which in all probability owes its presence to this group of ectoparasites.

The recognition of mosquito-borne diseases marks one of the most important advances in modern times. Thanks to the work of Ross, Grassi and many others, we learned that malaria was transmitted solely through the bite of the mosquito. The life history of the parasite in the *Anopheles* has been traced, most completely, from the moment when it enters the stomach with the ingested blood, until it leaves the insect by way of the salivary secretion.

Barely a decade has passed since yellow fever was shown by Reed and his co-workers to be similarly transmitted, though by another genus of mosquito, the *Stegomyia.* The cause of the disease escaped their search, and for that matter is still unknown, but the practical results which followed from their work culminated in the complete conquest of a hitherto uncontrolled scourge.

Did time permit, some consideration could be given to insect carriers, such as the body louse, which has to do with the transmission of relapsing fever and typhus fever in man, and the trypanosome infection in the common rat; the bed-bug, which has often attracted attention in connection with plague, relapsing fever and kala-azar; and to the sand-fly, which has recently been shown to be responsible for the pappataci fever, which is due, like dengue and yellow fever, to a filterable, invisible virus. It will be better to pass these by and consider briefly a vastly more important carrier, the tsetse fly.

Curiously enough, the tsetse-fly disease of South Africa was the first disease clearly recognized as insect-borne. The natives, as well as the early travelers, realized that the bite of the tsetse fly caused sickness and death of the animals thus bitten. The work of Bruce in 1894 proved this relation and at the same time demonstrated that the disease was due to a blood parasite, since named, *Tr. Brucei*. At that time Bruce was led to believe that the fly was infective for but a few hours, or at most a day or two after an infective feed. In other words, the fly was thought to be a passive carrier, simply carrying the parasite from one animal to another. This view has been definitely set aside as a result of the studies of the past two years. Mechanical transmission, especially where interrupted feeding occurs, is possible, but that this is the natural way is no longer believed. That the tsetse fly obtained its infection from the wild animals was a reasonable supposition, which was soon confirmed by special examinations. The important fact was established that the wild animal, recovering from the infection, became a chronic carrier and as such served as a natural reservoir of the virus. As long as such wild animals existed, the fly could infect itself and transmit the disease to the passing domestic animal. The introduction of rinderpest into South Africa is said to have brought about the destruction of wild animals to such an extent as to render this disease a negligible quantity in that region.

Especial interest centers about the tsetse fly because of its relation to sleeping sickness, which is caused by the *Trypanosoma gambiense*. While the fly, *Glossina palpalis*, is chiefly responsible for the spread of this disease, there is reason to believe that other species of tsetse flies can likewise serve as carriers. Attempts to eradicate the disease by removing all of the natives from certain regions have failed to accomplish the desired result. The tsetses undoubtedly obtain their infection from some other source than diseased man. This natural reservoir of the virus has not as yet been discovered, although from experiments made on antelopes it is not unlikely that these or related animals constitute the chronic carrier from which the infection is transmitted to man by the fly.

The question as to whether the tsetse fly could act as an active carrier was finally settled by Kleine (1909) and confirmed by Bruce and his co-workers. It is now known that flies which feed upon infected animals remain harmless for a period of about three weeks. After that time, however, they become infective and apparently remain so during the remainder of their life. Only a small percentage of the flies thus fed become infected. The changes which the trypanosome undergoes in the fly are but partly known. Whether this parasite has an intracellular stage, such as has been observed in fleas infected with *Tr. Lewisi*, remains to be demonstrated. It is certain, however, that *Tr. gambiense*, when it once adapts itself to the conditions in the digestive tube of the fly, then multiplies in much the same way as it would in the culture tube. It is an interesting fact that when blood containing *Tr. brucei* is planted on a suitable culture medium an incubation period of from two to three weeks is necessary to bring about this adaptation. It is not unreasonable to believe that the changes which take place in the test-tube are not unlike those which occur within the digestive tube of the fly. The successful cultivation of *Tr. gambiense* has not as yet been realized and hence comparison of the two can not be made.

Frederick G. Novy
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CONCERNING NOMINA CONSERVANDA, AND A REFERENDUM TO ALL ZOOLOGISTS

The *Zoologischer Anzeiger* for January 3, 1912, publishes the result of an extensive mail vote taken among the professional zoologists of Denmark, Finland, Norway and Sweden, for and against the strict application of the law of priority in all cases, the negative vote expressing the desire that the most important and generally used names should be protected against any change on nomenclatural grounds. The vote was taken among professional zoologists, excluding anatomists, paleontologists and amateurs. Dr. Th. Mortensen, in reporting the results, comments as follows:

> The result of the vote is very striking. Of the 122 names there are two for the strict application of the priority rule in all cases, which means less than two per cent. It may perhaps not be unreasonable to conclude from this result that the number of those zoologists who swear to the strict application of the priority rule, is upon the whole very small, the great majority wishing to have the names preserved unaltered.
>
> It is to be hoped that the zoologists of other countries will follow the example given here. When this has been done and it has been definitely proved that the great majority object to the strict application of the priority rule, it may perhaps be expected that the tyranny of that notorious law, which has already done so much to damage science, will be thrown off.

The Entomological News for March, 1912, in an editorial on this subject offers to receive and print the names of any American zoologists who will send in their votes.[1] It is to be hoped that all zoologists of this country interested in the names of animals will register their votes as suggested.

Any general concurrence in the protest against the strict application of the law of priority in all cases should not be accepted as a licence for every zoologist to adopt any names that he chooses. No individual should take it upon himself to waive the rules, but in specific cases where clearly greater convenience will result from setting them aside, this should be done by such a centrally organized and authorized body as the Commission on Zoological Nomenclature. Such a body should work toward the compilation of a list of *nomina conservanda,* and the names of such a list, once adopted by the International Congress, should never be open to future change on nomenclatural grounds.

The adoption of a list of *nomina conservanda* is not without precedent. The botanists have such a list, and it appears to work well. Article 20 of the International Rules of Botanical Nomenclature reads:

> However, to avoid disadvantageous changes in the nomenclature of genera by the strict application of the rules of nomenclature, and especially of the principle of priority in starting from 1753, the rules provide a list of names which must be retained in all cases. These names are by preference those which have come into general use in the fifty years following their publication, or which have been used in monographs and important floristic works up to the year 1890. The list of these names forms an appendix to the rules of nomenclature.

The next meeting of the International Zoological Congress will occur in July, 1913, and any proposed change in the rules of nomenclature must be forwarded to the commission a year in advance of the meeting at which

[1] To Dr. P. P. Calvert, editor, 4515 Regent St., Philadelphia, Pa.

they are to be considered. Therefore, in order to bring the question of *nomina conservanda* before the next International Congress, we, the undersigned, have drawn up and forwarded to the secretary of the International Commission, Dr. Ch. W. Stiles, Washington, D. C., the following proposal:

PROPOSED AMENDMENT TO THE INTERNATIONAL CODE OF ZOOLOGICAL NOMENCLATURE

To add to Article 26.

To avoid disadvantageous changes in the nomenclature of genera by the strict application of the rules of nomenclature, and especially of the principle of priority, the International Commission on Zoological Nomenclature is empowered to prepare a list of names to be retained. These names are to be by preference those which have come into general use in the fifty years following their publication, especially those generic names upon which long used family names are based and those which have been used in monographs and important works up to the year 1890. With each generic name thus conserved is to be cited a type species, to be chosen with a view to retaining the name in its most widely known sense, even if thereby an exception must be made to the other provisions of this code.

We beg leave to suggest to American zoologists individually and to zoological societies the need that the commission be fully informed as to the state of opinion among us concerning the substance of this proposal. The commission has in times past published an invitation to all zoologists to send in proposed lists of *nomina conservanda*, and has met with little response. This was doubtless due to the form of the invitation, the data called for being far more than any of us had time to compile. It will require little effort to write a postcard to the secretary of the commission, expressing approval or disapproval of plan proposed; it will be easier still to vote "yes" or "no" to a question prepared for circulation among the members of any society having zoological interests. It is urged that in all zoological societies, such an inquiry be circulated for personal signature, and that the result of the vote be forwarded to the commission and also published in the scientific press. We entertain a hope that the real opinion of zoologists may thus find expression, and that such expression may so influence future rule-making as to prevent the unspeakable confusion of our literature that already impends.

(Signed)

J. C. BRADLEY	G. W. HERRICK
J. H. COMSTOCK	C. R. CROSBY
J. G. NEEDHAM	A. H. WRIGHT
H. D. REED	R. MATHESON
W. A. RILEY	G. C. EMBODY
ANNA H. MORGAN	

THE RAINEY AFRICAN COLLECTION

THE final shipment of the extensive natural history collection made by the Paul J. Rainey expedition in British East Africa, numbering some fourteen barrels and thirteen cases, has been received at the U. S. National Museum, and is being unpacked in the taxidermy shops. The collection is of large size, including some 4,000 specimens, more than 700 of which are those of large game.

Mr. Edmund Heller has been the guest of Mr. Paul J. Rainey on his African hunting trip, and accompanied the expedition for the purpose of preserving the animals secured. Mr. Rainey has donated the entire collection to the Smithsonian Institution and the National Museum. While Mr. Heller had charge of the preservation of mammals in general, he paid special attention to collecting carnivores and ungulates. In a Smithsonian publication, now in press, Mr. Heller describes twenty-four new species of African rodents found in the collection. During the trip Mr. Rainey granted Mr. Heller every opportunity to make a complete survey of mammals. His assistants, twenty or thirty trained negro skinners, porters, etc., were employed by the safari.

Among the material obtained is the series of lions captured by Mr. Rainey's American bear-hounds, as described in his well-known lectures. There are also many specimens of different kinds of antelopes, including the hartebeestes, wildebeestes and waterbucks, as well as buffaloes, zebras, cheetahs, monkeys and rodents. A few hippo skulls and rhino skins and one elephant were also collected. A large number of birds was secured, including some of the rarest species. Many are game birds, among them guinea-fowls and francolins (which resemble our partridges), and plantain-eaters, crows, bustards, vultures, vulturine guinea-fowl, owls, hawks, kites, secretary birds, horn-bills, pigeons, parrots, sun-birds, flycatchers, etc., are represented. There are also four ostrich eggs.

The party remained in the field nearly a year, having sailed from New York for Mombasa on February 18, 1911, not dispersing until about February 15, 1912, at Nairobi. The territory traversed was mostly to the north and east of that covered by Colonel Roosevelt on the earlier Smithsonian expedition, and included the country lying between the northern part of British East Africa and southern Abyssinia.

THE TWELFTH INTERNATIONAL GEOLOGICAL CONGRESS

The International Geological Congress, on the joint invitation of the government of Canada, the provincial governments, the Department of Mines and the Canadian Mining Institute, will hold its twelfth meeting in Canada during the summer of 1913. It is proposed to hold the meeting in Toronto, beginning on or about the twenty-first day of August. The congress will continue in session for eight days.

The following topics have been selected by the executive committee as the principal subjects for discussion:

1. The coal resources of the world.
2. Differentiation in igneous magmas.
3. The influence of depth on the character of metaliferous deposits.
4. The origin and extent of the pre-Cambrian sedimentaries.
5. The subdivisions, correlation and terminology of the pre-Cambrian.
6. To what extent was the Ice Age broken by interglacial periods?
7. The physical and faunal characteristics of the Paleozoic seas with reference to the value of the recurrence of seas in establishing geologic systems.

The executive committee of the Eleventh Congress, held in Sweden, compiled and published a comprehensive report on the Iron Ore Resources of the World. The present executive committee has undertaken the preparation of a similar monograph on the Coal Resources of the World. In order to make the work as complete as possible the cooperation of all the principal countries of the world has been invited. This invitation has met with a cordial response, and it is hoped the volumes will be ready for distribution before the meeting so that they may constitute a basis for discussion at the congress.

Arrangements have been made for a series of excursions before, during and after the congress which will enable the members to gain a knowledge of the geology and physiography as well as the mineral resources of Canada.

The honorary president of the congress is the Duke of Connaught, governor general of the Dominion of Canada. The president is Dr. Frank D. Adams, dean of the faculty of applied science and Logan professor of geology, McGill University, Montreal, and the general secretary is Mr. R. W. Brock, director of the Geological Survey of Canada.

SCIENTIFIC NOTES AND NEWS

At the celebration of the seventy-fifth anniversary of the foundation of the University of Michigan on June 27, the degree of doctor of laws was conferred on Dr. Henry S. Carhart, professor of physics there from 1886 until his retirement in 1909 as emeritus professor. As already noted in Science, the degree of doctor of science has been conferred on Dr. Carhart by Northwestern University, where he was professor of physics from 1872 to 1886.

Yale University has conferred the degree of doctor of science on Professor H. T. Eddy, dean of the graduate school of the University of Minnesota. Professor Eddy, who is president of Sigma Xi, gave one of the addresses of the joint meeting of the members of the societies of Phi Beta Kappa and Sigma Xi.

The University of Pittsburgh has conferred the degree of doctor of laws on President E. F. Nichols, president of Dartmouth College, and on Dr. Charles D. Walcott, secretary of the Smithsonian Institution.

Dr. Lewis Boss, director of Dudley Observatory, has received the doctorate of science from Dartmouth College.

The University of Colorado conferred the degree of doctor of laws on Dr. Florian Cajori, professor of mathematics in Colorado College.

The Royal Society of Edinburgh has awarded to Professor Alexander Smith, professor of chemistry in Columbia University, the Keith Prize for the biennial period 1909–1911. The award is made for his researches upon sulphur and upon vapor pressure, which have been published in the *Journal* of the American Chemical Society.

The Franklin Institute of Philadelphia, Pa., has awarded the Edward Longstreth medal of merit and diploma to Dr. Charles Baskerville, professor of chemistry and director of the laboratory at the College of the City of New York, for his investigations on the chemistry of anesthetics (ethyl ether, chloroform, nitrous oxide and oxygen).

According to *Nature* the list of honors on the occasion of King George's birthday, which was celebrated on June 14, includes the name of only one fellow of the Royal Society, Lieut.-Col. D. Prain, director of the Royal Gardens, Kew, who has been knighted. Among others upon whom a like honor has been conferred are Mr. B. G. A. Moynihan, professor of clinical surgery at the University of Leeds; Mr. C. H. Read, president of the Society of Antiquaries; Mr. J. Bland Sutton, the distinguished surgeon; Dr. St. Clair Thomson, professor of laryngology and diseases of the throat at King's College Hospital. Another honored member of the medical profession is Mr. R. J. Godlee, president of the Royal College of Surgeons, who has been created a baronet. The Companions of the Order of St. Michael and St. George (C.M.G.) include Dr. A. Balfour, director of the Government Research Laboratory, Gordon Memorial College, Khartoum; Mr. J. Currie, principal of the same college, and Mr. J. M. Macoun, assistant botanist and naturalist, Canadian Geological Survey. Dr. G. A. Grierson and Dr. M. A. Stein have been appointed Knight Commanders of the Order of the Indian Empire (K.C.I.E.), and among the new Companions of the same Order (C.I.E) are Mr. B. Coventry, director of the Indian Agricultural Research Institute; Mr. A. Chatterton, superintendent of industrial education, Madras, and Dr. P. C. Ray, professor of chemistry, Presidency College, Calcutta.

Dr. C. J. Martin, F.R.S., director of the Lister Institute of Preventive Medicine, London, has been elected an honorary member of the Royal Society of New South Wales.

Dr. W. W. Campbell, director of the Lick Observatory, expects to visit the D. O. Mills Observatory at Santiago, Chili, which is under his charge. Mr. Ogden Mills will continue to maintain the observatory for 1913 and 1914.

Dr. Charles D. Walcott, secretary of the Smithsonian Institution, has left Washington for British Columbia, where he will continue his studies in Cambrian geology and paleontology.

Dr. Simon Flexner, director of the laboratories of the Rockefeller Institute for Medical Research, who went abroad last February to give lectures at the Edinburgh University and the Royal Institute of Public Health, London, has returned to New York.

Dr. G. Patterson, Jr., assistant professor of chemistry in the University of Notre Dame, has accepted a position with the government of the Republic of Panama and will sail from New York to take charge of his duties some time this summer.

Mr. Howland Bancroft has resigned from the U. S. Geological Survey, with which he has been connected since 1907, and will enter practise as a consulting mining geologist.

Dr. F. E. Lloyd, professor elect of botany in McGill University, will spend a portion of the summer at the Carnegie Institution of Washington Botanical Laboratories at Carmel, Cal., and Tucson, Ariz., continuing his investigations of transpiration in cotton and other, chiefly halophytic, plants.

Mr. N. Banks, Bureau of Entomology, has gone to Europe to spend a few months studying in various museums.

At the Worcester Polytechnic Institute a fund has been established to be called the Leonard P. Kinnicutt Student Loan Fund, with certain sums of money left after the discontinuance of Newton Hall, for eight years the institute dormitory on State St. Dr. Kinnicutt, while professor of chemistry, was chairman of the faculty committee in charge of the dormitory, and was always active in helping students financially and in other ways.

A memorial service in honor of Robert Koch was recently held in a temple dedicated to him, which has been erected at Tokyo. The temple owes its origin to the interest of Professor Kitasato.

We learn from *Nature* that Lady Hooker will be grateful if any of her friends who possess letters written by her late husband, Sir Joseph Hooker, will lend them to her for the purposes of a biography which Messrs. Smith, Elder and Co. will publish. The letters, which should be forwarded to Lady Hooker at The Camp, Sunningdale, will be carefully returned.

The death occurred on June 13 of Dr. Shadworth H. Hodgson, the eminent British philosopher, at the age of seventy-nine years.

M. F. Lecoq de Bois-Baudran, the French chemist, has died at the age of seventy-four years. The Davy medal of the Royal Society was awarded to him in 1879, for the discovery of gallium.

Dr. Karl von der Mühll, professor of mathematical physics at Bâsle, has died at the age of seventy-one years.

M. C. André, director of the Lyons Observatory, has died at seventy-two years of age.

The death is also announced of Professor H. F. Weber, director of the Physical Electrotechnical Institute at Zurich, aged sixty-nine years.

The twenty-third annual conference of the Museums Association will be held in Dublin on July 8–12, under the presidency of Count G. N. Plunkett, director of the National Museum of Ireland.

The program for the meeting of the British Association at Dundee on September 4 and following days includes garden parties at Glamis Castle, Kinfauns Castle, Rossie Priory and Camperdown and excursions to St. Andrews, Dunfermline, Arbroath and Aviemore. The president, Dr. Schäfer, of Edinburgh University, will devote his address to the developments that have taken place during the last 50 years through the study of the tissues of the body by means of the microscope. Professor Bragg will discourse on "Radiations, Old and New," and Professor Keith on "The Antiquity of Man." The lord provost, magistrates and citizens of Dundee are cooperating with the officials of the association for the entertainment of the visitors. A hand-book on the city and its industries is in preparation.

The plan of Professor Willis L. Moore, chief of the United States Weather Bureau, for the establishment of an international North Atlantic weather service has been agreed to by the committee of the Radio Telegraph Congress meeting at London. According to the plan as outlined by Professor Moore, a median line will be established through the North Atlantic. All ships on either side of the line must take a daily weather observation which will be sent by wireless telegraphy to other vessels and thus relayed to the American or European land stations. From these reports weather charts will be constructed and forwarded to the shipping at sea.

Professor W. H. Perkin has read a paper before the Society of Chemical Industry, announcing that rubber has been synthesized, and that this synthetic rubber can be placed on the market at a price to compete with plantation rubber. According to the account in *Nature* it was reported that Professor Fernbach, of the Pasteur Institute, was, after eighteen months of laborious work, able to produce a fermentation process for the production of fusel oil from any starchy material. The process is now so satisfactory that the higher alcohols can be obtained at a cost of not more than £30 per ton. Having produced isoprene cheaply, the next consideration was how to polymerize it and convert it into rubber satisfactorily. The discovery of the cheap method for preparing isoprene was first suggested by Dr. Matthews. In 1909 Mr. E. Halford Strange, of Messrs. Strange and Graham, technical research chemists, directed his organization of chemists, headed by Dr. Matthews, to the problem of the synthetic production of rubber. Dr. F. E. Matthews suggested one method for preparing isoprene in which acetone was one of the raw materials, and later on one in which fusel oil was the starting product. Professor Perkin was then asked to cooperate, and later on Sir William Ramsay joined the group as consultant. In July, 1910, Dr. Matthews left some metallic sodium in contact with isoprene, and on returning from his holidays in September found that the isoprene had turned into a solid mass of rubber. On further investigation it was found that sodium is a general polymerizing agent for this class of material. The first announcement of this discovery was made by Professor Carl Harries, of Germany, who had made the same discovery independently, about three months later.

President Taft has just made considerable changes in the National Forests in Montana, Arizona, Nevada, Utah and California through presidential proclamations modifying the boundary lines. By these changes nearly 275,000 acres of land are eliminated from the forests, about 65,000 acres are added, and about 55,000 acres are transferred between two forests, while a new forest is created by the division of an old unit into two. The net result is to bring down the total gross area of the national forests to about 187,400,000 acres, of which nearly 27,000,000 acres are in Alaska. To a considerable extent, however, the reductions, so far as land actually owned by the government is concerned, are apparent rather than real, owing to heavy alienations in the tracts eliminated. Some 22,000,000 acres of the national forest gross area are not owned by the government. The high-water mark of the national forest gross area was reached in 1909, when the forest boundaries included over 194,000,000 acres. It was then realized, however, that in making the examinations on which the presidential proclamations creating the forests were based the work had been too rapid to insure in all cases the best boundaries. Sometimes land which should have been included was left out, while at other times land was taken in which was not best suited to forest purposes. Consequently a complete overhauling and rectification of the forest boundaries was planned, and has been going on ever since. By successive proclamations President Taft has eliminated nearly 11,000,000 acres, while he has added about 4,000,000 acres. In Montana, the new proclamations eliminate a total of 116,370 acres from six forests—the Custer, Absaroka, Blackfeet, Kootenai, Lewis and Clark and Flathead—while 14,640 acres are transferred from the Blackfeet to the Kootenai and 40,640 from the Kootenai to the Blackfeet, to facilitate administration. In Arizona, 106,540 acres are eliminated from the Coronado National Forest. In Nevada, 49,840 acres are eliminated from the Humboldt and 55,840 acres added, of which 12,800 acres are included in the new Ruby National Forest, composed principally of that part of the old Humboldt lying south of the Southern Pacific Railroad. In Utah, 1,340 acres are eliminated from the Sevier, while in California 8,680 acres are added to the Shasta and 480 acres to the Klamath.

UNIVERSITY AND EDUCATIONAL NEWS

The income of the Henry O. and Mary A. F. Hotchkiss bequest, which will eventually revert to the Sheffield Scientific School of Yale University, is to be apportioned for the purpose of adding to the salaries of those who are employed as the principal professors, instructors or lecturers having severally the charge of the following subjects: mathematics, English, physiological chemistry, electrical engineering, architecture, mining engineering, metallurgy, mechanical engineering, history and sociology and commercial geography. It is understood that the estate will be between $500,000 and $600,000.

The sum of $25,000 as the nucleus of an endowment fund to increase the salaries of professors has been willed to the University of Pennsylvania by Mrs. Elizabeth Wharton McKean.

Brown University has completed the collection of an additional endowment fund of $1,000,000 from some twenty-five hundred donors. This is the third fund of this amount collected under the administration of President Faunce.

Announcement of plans for new building operations at the University of Chicago, to involve approximately $1,000,000, was made by President Judson at the eighty-third convocation. The new buildings, which are to be begun at once, and to be completed within two years, are: a building for the departments of geology and geography to cost about $300,000; a gymnasium for women, to cost approximately the same sum, and a building to house the classical departments and their departmental libraries, to cost $225,000. In addition, the widely known Marshall Field, on which take place the football and athletic contests, and which adjoins the great Bartlett Gymnasium, is to have grandstands built of cement, and is to be surrounded by a concrete wall.

The Sloane Laboratory of Physics of Yale University was dedicated as part of the commencement exercises. A brief address was made by President Hadley. Messrs. Henry T. Sloane and Wm. B. Sloane, of New York City, who provided more than half a million dollars for the erection of the laboratory, were present.

Professor Arthur Michael, formerly of Tufts College, and Professor Elmer P. Kohler, of Bryn Mawr College, have been appointed professors of chemistry in Harvard University. Both will direct research in organic chemistry, and Professor Kohler will also conduct the chief undergraduate course in this subject and assume the charge of the introductory course in chemistry intended for those who have not pursued the subject in school. Professor Arthur B. Lamb, whose appointment as assistant professor has already been announced, will give another elementary course in inorganic chemistry (for those who have passed the admission examination in a satisfactory manner) and also conduct advanced instruction in electrochemistry. A further addition to the department of chemistry at Harvard is that of Dr. Grinnell Jones, of the University of Illinois, who has been appointed instructor.

Dr. Clark A. Hamann, professor of applied anatomy and clinical surgery, has been appointed dean of the medical department of Western Reserve University in succession to Dr. B. L. Millikan. Dr. Howard B. Haskins has been promoted to be associate professor of organic chemistry, and Dr. David Marine to be assistant professor of experimental medicine, and John S. Davidson to be associate in anatomy. Mr. Ralph J. Gilmore has been appointed instructor in biology.

At Brown University, Dr. Alfred H. Jones, of Cornell University, has been appointed professor of philosophy to succeed Dr. Alexander Meiklejohn, elected to the presidency of Amherst College. Mr. Alfred C. Hawkins has been appointed instructor in geology. Promotions include: William H. Kenerson, associate professor of mechanical engineering, to become professor; Roland G. D. Richardson, assistant professor of pure mathematics, to become associate professor; James A. Hall, assistant in mechanical engineering, to become instructor.

At the Worcester Polytechnic Institute Dr. Levi L. Conant, professor of mathematics, has been continued by the trustees as acting president. To relieve Professor Conant, Dr. Raymond K. Morley, now of the University of Illinois, has been appointed assistant professor of mathematics. John Harlan Nelson, of the Case School of Applied Science, has been appointed head of the department of applied mechanics, to fill the place vacant by the death of Professor E. L. Hancock; H. S. Ives has been promoted to be professor of railroad engineering; Dr. A. W. Hull, to be assistant professor of physics, and T. R. Briggs has been appointed instructor in chemistry.

Walter Fenno Dearborn, Ph.D. (Columbia), recently professor in the school of education of the University of Chicago, has been appointed assistant professor of education at Harvard University.

Dr. Harlan Updegraff, specialist in school administration, United States Bureau of Education, has been appointed professor of education and head of that department in Northwestern University.

Mr. James Knox Taylor, supervising architect of the treasury department, has been elected professor of architecture in the Massachusetts Institute of Technology.

Dr. R. F. Baunel, of the department of chemistry of Syracuse University, has accepted an appointment as associate professor of organic chemistry at Bryn Mawr.

The board of trustees of Jefferson Medical College has elected to the chair of chemistry, made vacant by the resignation of Dr. James W. Holland, Professor Philip B. Hawk, of the University of Illinois.

Mr. H. T. Plummer, assistant at the Oxford University Observatory, has been appointed Andrews professor of astronomy at Dublin University and astronomer royal of Ireland, as successor to Professor E. T. Whittaker, who has been called to Edinburgh University to the chair of mathematics vacant by the death of Professor Chrystal.

DISCUSSION AND CORRESPONDENCE

PRIORITY VS. NOMINA CONSERVANDA

We all agree that nomenclature is a means, not an end, and should be of service alike to general or special workers in other lines as well as to the student of a restricted group. We must also admit the human element, the personal equation, which is an important factor in applying the law of priority as well as in the selection of *nomina conservanda*—mistakes may be made in either case. It can hardly better matters to defer the correction of an error till some central representative body (usually with no special knowledge of the particular problem) gives assent to a change several years after the mistake has been discovered.

The men of science should stand for truth and freedom to proclaim the truth. An investigator should not be expected to hold an important contribution three to five years in order to secure the assent of any body to an obviously necessary change. Some scientific men may even desire to exercise a little personal discretion as to what names they will employ. Chaos does not necessarily follow unless we attempt to keep in mind the latest changes in all groups. Some appear to be taking priority too seriously; others propose new genera with inadequate descriptions or figures and, too frequently, in obscure, more or less irrelevant notes; while synonymy may be indicated with even less regard for the convenience of the investigator. These practises are certainly not commendable, since they may be serious stumbling blocks for subsequent workers. The writer believes in the strict application of the law of priority because it appears to be the only ultimately stable basis for nomenclature, and yet he practises or endeavors to practise conservatism in accepting changes in groups with which he is comparatively unfamiliar. A scientific man need not apologize for not using the very latest generic term. He may prefer to retain an open mind toward the innovation and adopt it with the appearance of a comprehensive memoir or a standard catalogue.

Let us see how the strict application of the law of priority works out in the gall midges or Itonidæ, much better known as the Cecidomyiidæ. *Itonida*, it may be recalled, was one of Meigen's names published in 1800, *Cecidomyia* being substituted therefor in 1803. In the past, *Cecidomyia* has been applied in a restricted sense by different students to forms referable to widely separated tribes (Dasyneuriariæ and Itonidinariæ), not to mention the indiscriminate use of the name for any or almost any gall-making midge. It was necessary, under the old state of affairs, to either know the species or the sense in which the name *Cecidomyia* was used in a paper before one could form a definite concept of the characters for which the term stood in that particular instance. The loose application of this name to a thousand or more species referable to over 150 genera, did not materially enhance the value of the word as a precise scientific designation. In this instance the use of the prior *Itonida,* which has not been misapplied, savors more of common sense than an attempt to put among the *nomina conservanda* the variously defined and loosely applied *Cecidomyia,* even though the latter has become well established and is generally used in economic literature. A survey of the group would show that even if *Cecidomyia* was retained, it could be applied to but one genus, and that would mean that the accepted generic name for most of the economic species must of necessity be changed. *Cecidomyia* is a valuable designation and can and should be employed as the name of a biological group.

The gall midges may present exceptional conditions. We are by no means certain that the strict application of the law of priority means more incumbrances and difficulties than the establishment of *nomina conservanda.* Many of the changes necessitated by the law of priority have been made. Shall we reverse ourselves? If so, how many will accept this change of attitude and to what extent shall we go? If "well-established" or "long-used" names are desirable, how shall we select these? Is usage by the biologist, general zoologist, taxonomist, the economic entomologist or the agriculturist to determine which shall be employed? Further study will inevitably result in closer generic definition. Shall we recognize *Cecidomyia* as a valid genus with *destructor* Say as type because this is the more important agricultural species—and it is the practical entomologist who has done most to make this name current, or accept *pini* DeGeer as type and be compelled to use a less familiar term in economic literature?

In other words, the establishment of *nomina conservanda* may fix the generic term and designate the type, only to find later that the latter is not cogeneric with the species which has made the generic name common property. This is strikingly shown by referring to a few of the well-known American forms which probably would have been changed even if *nomina conservanda* had been in existence. The following are a few well-known species which have been shifted from one genus to another because of a more correct generic definition:

Ægeria exitiosa, now *Sanninoidea,*
Arctia isabella, now *Isia,*
Orgyia leucostigma, now *Hemerocampa,*
Anisopteryx pometaria, now *Alsophila,*
A. vernata, now *Paleacrita,*
Incurvaria acerifoliella, now *Paraclemensia.*

The above names have been widely current as well as many others now relegated to synonymy, and their retention is impossible unless generic limitations are broadened, and then it would be necessary to harmonize very wide divergencies of opinion. Has any one an adequate notion as to just how much relief would be afforded by the establishment of *nomina conservanda?* Is there not a possibility that the benefits supposed to accrue therefrom have been greatly overestimated?

Finally, has sufficient time elapsed to permit a determination of the wisdom or unwisdom of a strict adherence to the law of priority? Can we assure ourselves that a comfortable adjustment to existing conditions is impossible for most individuals?

E. P. Felt

Albany, N. Y.,
May 10, 1912

HERMAPHRODITE SHAD IN THE DELAWARE

Instances of hermaphroditism occur occasionally in the shad (*Alosa sapidissima*) taken during the spring in our fisheries, though they are usually so infrequent as to arouse the curiosity of the fishermen. I know of two cases, both of which specimens were given to me for examination. They were obtained from fully adult fishes, which did not differ externally from the other normal ones with which they were associated. Before being opened both the examples were classed as males or "bucks." The first example was taken near Camden, New Jersey, in March of 1908, by Mr. J. B. Fine. The organs of this fish were of the average size in length, though each lobe was sharply divisible into two sections of nearly equal dimensions, these sections being well constricted where they joined in the middle. The anterior section was composed of milt and the posterior of roe. My other example was secured by Mr. Horace H. Burton at Lovett's fishery near Tullytown, Pa., in April of 1912. It was still more masculine, with the milt very large or as a single body, and the lobes nearly completely atrophied. The roe was quite small, twisted, posterior, and its lobes also more or less distorted by atrophy. Further, the roe exhibited curious milt-like globules or areas of variable size, some comparatively large, in several places.

Henry W. Fowler
Academy of Natural Sciences
of Philadelphia,
May 2, 1912

UNIVERSITY CONTROL

LETTERS FROM THE UNIVERSITY OF PENNSYLVANIA

As to heading (1) as I comprehend it the corporation would have no powers of controlling policies. In that case I approve of it. I should not approve of having policies controlled by so heterogeneous a body and one so ignorant of academic questions as are most alumni. I should approve of their having advisory powers as to policy, and direct powers in electing trustees, so that the latter may not elect themselves. (2) I am in doubt about the whole of this section. I think it would be better that the professors should nominate, say two men, to the trustees and let them elect, so that the faculties would still essentially make the choice, but the trustees have a part in the decision. If trustees are to have any usefulness their opinion should be of some value. I think if there is a president at all his powers, dignity and salary should be greater than that of a professor, as high administrative powers are rare and consequently of unusual value, and his duties, if conscientiously carried out, are more trying than those of a professor. Few men would accept them if they gained no added power or income and the position would otherwise be a sort of head-dean. I believe some such officer is necessary, in the present age, at any rate, but I do not think he should have power of appointments, but that these should come from the faculty, that is, from the unit-faculty to which the position to be filled belongs, as nominations, and be ratified by the trustees or other advisory board. I am inclined to think that the best way to hold the president in check would be to give him an unlimited term of office, but to give the faculty of the whole university power of veto by a two thirds or three fourths vote in any of his proposals that affected the general university, and perhaps to give the unit-faculties power of veto by a large majority vote—say four fifths, or power to demand that any policy affecting the unit be carried before the whole university faculty and voted upon; and then consider a veto the fall of the ministry. This would probably lead to closer relations between all individuals in the faculties and the presidential policies and conflicts would be settled early by discussion rather than by quarreling. It would involve also that the faculty be officially apprised at all times of what is being planned long before it was done. This is rather half-baked, as I express it. I do think, however, that what we need is to encourage the development of enlightened and able administrators rather than to clip their wings. (3) I approve of this. (4) I highly approve having outside experts called in to decide the choice of professors and I believe this might be required in certain other matters. I do not believe it is possible to pay the same salaries for the same office. This to my mind has the fatal danger that prevails in the labor unions, with their limitations of productivity and would interfere with progress. If one man is a greater and more important man than another he is worth more to a university than a lesser man, even though both do the same amount of actual university work. I should approve of having a certain percentage of trustees graduates of other institutions and, except in the case of state universities, have, say, half of them reside elsewhere than in the town where the university is situated. I would also require that four fifths of the trustees should themselves be university graduates of some sort. This would still leave some places to be filled by uneducated rich men who know nothing of a university's needs—but not a majority.

I should say that the plan is an excellent one in theory, but whether we shall ever see it tried practically may be a question. Of course universities, like everything else, are a product of evolution. Such institutions in this country appear to have reached the stage where they call for an autocrat, precisely as it appears necessary to have a boss in city and state government. In process of time we may expect the important universities of the country to outgrow this condition of things, but precisely what will take its place no one can say. It is not necessary or desirable that all should be organized on one plan, and perhaps the autocrat may remain a permanent feature of some institutions.

I should very much like to see one or more of the universities of the country put into practise a plan of control along the lines that you have suggested. There is fortunately a rivalry so keen that the universities which best serve the community are going to be those that will most prosper, and service to the community depends fundamentally upon an organization which will attract and hold the best men to its faculties. I have seen thoroughly bad results under the head-professorship system and equally unfortunate conditions in departments largely autonomous, where a group of older men of similar sympathies are holding back progress with serious results. The difficulty is to strike the means by which a department may be left autonomous as long as its actions are progressive, but may be brought up with a firm hand when it appears that a group of its professors are working for selfish ends or are exhibiting evidences of servile incompetency. I am inclined to think that the best checks are through criticism freely expressed by deans and other administrative officers and by committees, and freely asked by the president. The university in which is possible such criticism and consultation among its administrative officers is most fortunate.

Excepting in some minor details, and in the matter of the status of the president, I am entirely in agreement with you. Regarding the president, it seems to me that as conditions are changing much from time to time a longer tenure of office than that of the rectors of German universities would be desirable, and I think that for many reasons it is desirable that greater power should be concentrated in one technically qualified person than your scheme seems to allow. This need not run counter to your idea of a democratic institution, since the power is, after all, delegated from the faculty to the person selected by them for the position of president. An assurance of considerable tenure of office and a somewhat distinctly higher position, both in salary and in dignity of position, should, I think, be given the person known as president.

I believe the reform in university administration which you propose to be a very desirable step in advance. Perhaps I may be permitted to suggest an amplification in one or two points: (1) The meeting of the corporation for the election of trustees should not be under the chairmanship or influence of any of the trustees. Not uncommonly the meeting of a larger body when presided over by a member of the smaller directing body is merely a nominal affair, approving the proposition agreed upon beforehand by the members of the smaller body. The larger body usually does not take the initiative in any matter of importance whenever members of the smaller directing body take an active part in the proceedings of the larger corporation. (2) The selection of professors and instructors is a most important matter. In the past the selection has been intrusted to administrative officers who usually relied upon the judgment of one or two men prominent in the special field in which a vacancy had to be filled. In very many cases one and the same man had thus the power to fill the most important positions. Such a procedure must naturally lead to conditions somewhat similar to those found in "politics." A personal element will be of influence in the selection of men for professorships. There is danger that the man who is most frequently consulted will, perhaps against his own inclination, be forced to assume the rôle of a political "boss," and that the building up of something like a political machine will result. Men of a certain school will be preferred for the filling of the most important positions. The committee having in charge the selection of a professor should, therefore, as a matter of routine, consult a large number of representatives of a certain field of science, preferably representatives residing in more than one country, in order to eliminate any personal bias, and to effect a selection on the basis of merit. Such a committee should submit the names proposed by the various experts to the senate for final election.

In the main I thoroughly agree with your views. We are certainly sorely in need of a revision of the prevalent methods of running universities. It seems that in most institutions the board of trustees do not look upon the faculty as the living part of the university, but as a lot of laborers who should be placed upon the same basis as "hired help" generally. There is certainly vastly too much politics in professorial life, and there is too much done to please certain interests, right or wrong. In fact there are so many evils and weaknesses that are so manifest in the administration of university affairs and so desirable to be corrected that one could write an elaborate thesis on the subject without seeking for material. This must be a matter of evolution and not of revolution. Your article is in the right direction.

I think your plan of university control on the whole a very good one; but you have not stated how a university senate should be constituted and elected. Further, it seems to me that any nomination for professorship passed by the board of advisers should not be subject to the veto of the trustees.

Your plan seems to safeguard very well the interests both of the organization and of the individual.

I am in thorough sympathy with the plan of university control as outlined by you. Two factors which make for faculty incompetence, in the medical schools at least, are self-interest and the dread of unpopularity among colleagues. This is particularly true of the clinical men whose business interests are not always in accord with a university's interests and for whom popularity is a business asset. These two factors frequently stand in the way of advances of benefit to a university.

I find your plan excellent, and approve of it. I beg to suggest that one indirect effect of the present system has not been mentioned in your indictment: namely, the policy of academic advancement of the man who draws the largest classes, rather than the man who does the best work. It has been my observation that presidential favor is frequently curried in this way, to the detriment of men whose ideals will not permit them to lower the standards of their work for popularity.

I heartily agree with your sentiments as to a strictly democratic organization, where no one man, or group of men, can set themselves up as a dictator. The corporation, to my way of thinking, should consist of several groups of men chosen from different sources of supply. It should consist of, say, fifteen members, selected as follows: the university professors should name three, the alumni organization five, the state legislature three, the educational board of the state two and the board thus constituted elect two other members from the community at large. These should, with the academic council in joint session, elect a president and a vice-president for five years. The faculty should name the academic council to which the questions of policy should be referred, presided over by the president. The professors, assistant professors and instructors should be assembled into groups, which groups would annually elect a chairman, and preferably in rotation. His sole duty would be to preside at group committee meetings, transmit their communications to the academic council and sign bills and other documents where such signature is necessary. In other words, the chairman of the group would be executive officer of the group for one year. The salaries should be uniform for professors and assistant professors, and of a sum sufficient for their needs and proportioned according to the length of active and honorable service, beginning with a minimum and ending with a maximum. The recommendations for advancement should start in the group committees, pass through the academic council and end with the corporation.

It must be apparent to most sincere and experienced observers of academic life in America that the present deficiencies in our universities are not so much a consequence of faults of organization as of certain fundamental defects in the dominant American conceptions of what the purposes and characteristics of university activities ought to be. The form of organization prevalent in the universities is an expression of the predominant characteristics of the men who are chosen to fill the influential positions. Men whose instincts are for practical life, rather than for study and the advancement of intellectual ideals and achievement, are chosen far too frequently. This is the chief source of weakness, since such men determine what shall be taught, how it shall be taught, the degree of freedom of research and of discussion, the aims which the institution sets before itself, in short the whole course of university policy. Such men admire the business type of man and try to imitate him; the result is that they have imposed on institutions of learning an organization better fitted for definite practical undertakings than for the diversified and largely disinterested activities of an assemblage of scholars. The system, in other words, favors the selection of men who lend themselves most readily to cooperative and directly practical undertakings—rather than of men who, like most true scholars, combine strong individuality with idealism. The evil is self-perpetuating, since almost all men will work effectively or ineffectively, according to the incentives offered; if devotion to study and research is self-penalizing, the number of men who vigorously and whole-heartedly so devote themselves is inevitably diminished. Hence, many university men deliberately prefer to perfect their capabilities in quite other directions than scholarship—even when they are not forced to do so—studying the arts of management, control, compromise, the technique of executive activity, and the like. Is it to be wondered at that the intellectual life of many institutions flags, that our scientific productivity is so far behind that of Europe, and that students of marked originality so frequently fail to receive the stimulus and opportunities they need for their proper development? Under conditions more favorable to the selection of superior men—like those hitherto prevailing in Germany, France or England—the tale would be a very different one. It is not that we lack the ability, but that it fails to realize itself because of a radically wrong basis of selection. I am well aware that there are many distinguished men in the American universities, but far fewer than there ought to be. The present organization of the universities, I repeat, is rather the expression of this deficiency than the cause of it. The fundamental cause lies in the prevailing temper and ideals of university men in this country. There are certain tendencies of American life —to a certain degree of all modern life— which a university should deliberately guard against and oppose. These are, many of them, to be counted among the more doubtful products of the democratic movement: the prevalence of mediocre or popular standards—*i. e.*, those which the common man can reasonably hope to attain—an uncritical faith in majorities, a pessimistic estimate of the possibilities of individual achievement, over-emphasis of the importance of cooperative activity ("team-play"). A preference for mediocrity and a disposition to neglect, disparage, or hinder men of pronounced genius arise from all this. The organization of the university should therefore encourage a liberal and enlightened individualism; the tendency to make men conform to fixed standards, whether set by academic authority or by what happen to be the fashionable prejudices of the time, should be frowned down, or, still better, laughed down. Under these conditions men of distinguished ability will be far more likely than at present to make their way into universities and to produce their best work. The existing organization of the universities over-emphasizes the managerial side for the reasons I have already briefly indicated. Hence I should favor a change in the direction of a general simplification and decentralization. With reference to the reforms you propose, my opinions are very much as follows. I refer to the numbered paragraphs of your article. (1) The professors should undoubtedly form part of the corporation; alumni and other members of the community only in so far as they show real knowledge of university conditions. Such a body could be depended upon to select suitable trustees. (2) The president should be elected by the professors from among their number for a fixed term (*e. g.*) four years. There should be no obstacle or limit to reelection; a good man would thus hold his place. (3) and (4) I favor all possible autonomy to schools, divisions, departments and individuals. Salaries of professors should be adequate and uniform. I am inclined to urge the adoption of a system like the Italian: *i. e.*, election of the professor by men of reputation in his own department of learning, in his own and other universities. (5) I approve of all these suggestions.

LETTERS FROM THE JOHNS HOPKINS UNIVERSITY

With regard to the first proposition, the suggestion of forming a corporation consisting of the professors, officers and alumni, does not meet my approval. The only feature that makes membership in such a corporation desirable is the privilege of voting for trustees. In the first place I do not feel that this privilege alone would suffice to secure a paying membership, such as is contemplated in the proposition. In the second place, I should not like to see trustees chosen by this method. It would seem to me to carry with it all the difficulties inherent in political elections—namely, parties, electioneering machinery—a continual agitation to arouse the interest of the better element to meet the designs of those who were acting from self-interest or ignorance. The most important work of trustees, in my opinion, is to safeguard the financial interests of the university, and for this purpose they should form a small body, the individuals of which should be selected by the board itself, or in the case of state universities by some responsible authority, *e. g.*, the governor of the state. It should be a permanent board made up of citizens of standing, men of integrity and ability, whose interest in public affairs will induce them to accept such a trust in spite of the fact that it brings work and responsibility without any personal profit. I do not feel that a board of this character can be obtained by a general election among alumni. It would be difficult or impossible for the alumni to acquire the information requisite for intelligent voting. In regard to the second proposition, I am heartily in favor of the suggestion that the president shall be appointed by the trustees upon nomination by the faculty—he should be the choice of the faculty—I believe that such a method of selection would strengthen greatly the bonds between president and faculty, especially if there was added the further provision that all appointments and appropriations be made upon recommendation of the faculty or of some board representing the faculty and chosen from its membership by election. I do not, however, agree to the latter part of proposition (2). I believe that the presidency should be a dignified and desirable office in order to attract the best men. It should be permanent, it ought to carry a salary larger than that of the professor, and the incumbent should be charged especially with the important duty of developing the policy of the university. Some one is needed in this position who is broad-minded enough to sympathize with good movements and to see that they are pushed—to recognize when there is weakness to be overcome or strength to be encouraged. No temporary officer can be expected to keep his mind constantly upon such work. If the office is temporary and carries no special dignity or importance, men will avoid it and, if forced to take it in rotation, will regard it as a necessary evil that they are thankful to escape from. Propositions (3) and (4) meet my general approval. When the size of any department is considerable, it would seem desirable to have its own faculty and dean, to make its own nominations to the staff and its own recommendations for appropriations and other departmental expenditures. As you say, such an organization practically exists for the professional schools, although in many cases the autonomy is not carried far enough, that is to say, it does not extend to appropriations and appointments. I count it unfortunate that there is a tendency to make the deanship in such departmental faculties a practically permanent office. In the case of professional schools that are not really incorporated into the university, such a provision may be necessary, but when the department is organically united to the university the deanship, in my opinion, should be an office filled in rotation, yearly, by the professors of the department. A department is small enough for the professors themselves, as a body, to develop their policy and supervise their own needs, present and future, and the dean should be simply an administrative officer for carrying their actions into effect. The office might properly be regarded as a burdensome duty and not an honor, and the labor might be shared equally so as not to spoil the efficiency of any professor in the proper work of his own subject. In this general respect I should like to see a marked difference made between the position of the president and the dean. The latter now generally fulfil the duties of minor presidents and there is no need, in my opinion, in one and the same university in having a group of men taken away from their proper work. It may very well lead to sharp antagonisms between individuals. In regard to proposition (5) I assume that some such representative body is necessary in large institutions where many departments exist. I would suggest that its most important function should be the recommendation of a proper division of the annual income among the several departments, in addition to acting as a final court in matters affecting the interests of all departments. It should be a representative body subject to change.

I thoroughly agree with (1) and the first part of (2); I think the president should be elected by the faculty and feel responsible to it for appointments, so far as they are in his hands, and general politics, but to the trustees for the financial part. I am inclined to favor a "rector" elected from the full professors for a period of, say, four years; his administrative work should not take him away from his department entirely. I believe that he should have a larger salary and be able to travel and entertain in the name of the university. A four years' tenure would put a man on his mettle, for I think he should be subject to reelection. I see evident weaknesses in this which I shall not discuss. (3) and (4) appeal to me and also (5) except for the last sentence. I do not believe that there is any group of men who abuse their freedom as much as do some university professors and I believe that this abuse tends to lower the average and dignity of all. You see, I am a complete Philistine on this subject. I believe that each head of a department should send the president a written report of his work at least every three months, these reports to be kept on file. I even favor the establishment of rules relating to hours. Of course I believe in absolute freedom in research, but I think it only fair that we give evidence of being worthy of our position and salary and see no reason for assuming that students and teachers are so different from the rest of mankind as not to need some control.

Along general lines I agree with you, as for instance, that the several faculties (law, medical, etc.) should possess autonomy, should nominate their own professors; that there should be as much flexibility and as little of the department-store system in a university organization as is consistent with the progress of research and with the advancement of learning. On these and many other points I should be at one with you, but when it comes to the details of a scheme such as you have analyzed I should wish time for study of the question—time to study the methods of university control in Germany, England and other countries—before expressing an opinion.

I think we are beginning to see indications for "university control" by the members of the faculty. Our medical faculty here is largely in control, not by right, but by assent. Such responsibility makes us more interested in educational problems, in economy of funds, and breeds loyalty, which, after all, is of the greatest of importance.

I can say that the plan of university organization that you outline strikes me as in its main lines highly desirable, and in its aims altogether excellent. With its leading purpose, that of securing and developing the independence and the individuality of the professor, I am in the heartiest possible sympathy.

On the whole your plan seems to me excellent. It is in accord with the historical development of university organization, and while very different from the plan now followed in America, it seems to me that a gradual adoption of it would be beneficial.

I approve of your scheme of university control.

I read your proposal with much interest and approval. I have no suggestions to offer at the present time.

Such an organization would go a long way towards solving our present difficulties of administration, meaning by "our" those of many institutions throughout the country. My limited experience with university presidents has led me to believe that some of them at least are incompetent. When it comes to new appointments, their lack of knowledge of suitable men to fill vacant positions is often surprising. I am fully convinced that the appointive or nominative power is best in the hands of such a committee as you suggest.

The democratic features of your plan must certainly appeal to all who are intimate with the present unsatisfactory state. I think any attempt at a modification of existing methods of university government should include some means of setting a standard for and effecting a scrutiny of the work of a department head. Existing abuse of the responsibilities of this position should not be lost sight of in your scheme.

I am very much in sympathy with your proposed plan of control of universities. In my estimation the president should have a somewhat higher salary than professors, but the differences that now exist in colleges as well as universities are unreasonable. The excessive (relatively excessive) salary commanded by certain presidents is, owing to their reputation as financial agents. If a man is able to raise money for an institution he can command almost any salary. Just what bearing your plan would have on the financial management of institutions of learning could hardly be predicted. However, it would tend to bring to the head of such institutions men of scholarship rather than men of marked business abilities and such men would undoubtedly, with the cooperation of the professors, as outlined in your plan, be able to direct the real functions of educational institutions infinitely better than an autocratic business executive.

Paragraphs (2) and (4) seem to me to be very well stated; certainly I subscribe to them most heartily. I confess that paragraph (1) is not so clear to me. I see possibilities there of great confusion. The corporation might easily become so large that certain tendencies and attitudes might be forced upon the professors which are not representative of the best interests of the university. If the voting power of the corporation could be so arranged that the professorial vote would represent half of the total and the outside members the other half, I think the plan might work very well. In regard to paragraph (3) it seems worth saying that the plan you call for is rather artificial unless you would hold to a more strict departmental grouping than I think your wording called for. Such large groupings would be hard to make and would eventually lead to friction. I think I am more in favor of autonomy for the professors than for the group, yet such a condition of affairs might lead to anarchy. The grouping psychology, philosophy, chemistry, physics, etc., are natural growths. In certain departments there are only one or two professors; such departments should be grouped by themselves and not forced to become a part of a larger whole.

I am heartily in favor of such a plan. I have been connected with German universities and have talked with a number of professors in Germany, France and England, as well as here in America. I feel very keenly that our present system will have to be modified somewhat according to your proposed plan, and it should be done as soon as possible. We are very fortunate here in Johns Hopkins University, of course, for we have, as you know, a university council which advises the president. Even here, however, there is a tendency toward an autocratic "one man power" in the departments, in that the so-called "director" of the department has considerably more authority than is sometimes wise. Although there is sometimes talk against our "one man system," you see that, as a whole, the wisdom of our leading men here in the university has kept things going on a sane basis. Considering the matter entirely independently of our own immediate surroundings, however, I should like to see a more democratic control established in our American universities.

I agree with you that for the successful development of the American university in the future, a change in the form of administration which at present dominates our higher institutions of learning is imperative. Certain recent developments have shown the danger of concentrating too much power in the hands of any one man. If a professor in one of our leading universities is to be dismissed not only without a trial before a jury of professors, but even without a hearing by the president of the university in question; the dignity and honor appertaining to an American professorship would be so slight that much of the very best intellect of this country would be turned away from the universities into safer channels. The result from this cause alone would be greatly to weaken our higher institutions of learning, and to foster the already overwhelming commercialism of this country. I think the policy outlined in (1) is good, except that I would not have a chancellor. The organization should be kept as simple as possible, to avoid any unnecessary sources of autocracy finding a foothold. All financial matters should be left to the trustees, and they should be expected to secure the necessary endowment. The financial affairs of the institution should be the chief, if not the sole, function of the trustees. I agree with (2), except I would not preserve the name president, since this has now come to have a well-defined significance. I would call the officer in question, perhaps, "rector," as in the German universities. He should be elected for one year, with the possibility of reelection—but in no case should be eligible for more than three years. His salary should be exactly that of a professor and his powers the same as those of any professor. His office, however, should, I think, be looked upon as even more dignified than that of a professorship. The point made in section (4), that the same salary should be paid for the same office, the same amount of work and the same tenure of office, is, I think, fundamentally important. This is, I believe, the case at Harvard, and largely the case at Yale. The opposite policy of obtaining, and especially of retaining, a professor for the smallest sum to which he, by any method, can be induced to submit, is short-sighted, and not conducive to the highest results. This method fosters discontent, and often indifference and inefficiency. It deals with the professor by the same method that a corporation deals with its hirelings, and thus detracts from the dignity and desirableness of the position. I would add that publicity in all such matters is absolutely essential to the good-will and harmonious working of an institution of learning. It might be urged as an argument in favor of the former, and against the latter system, that one professor is inherently worth more than another; and by the methods at present in vogue in making promotions this is true. But let no one be promoted to the rank of a full professorship in any one of our leading institutions of learning who does not measure up at least to a certain high minimum standard, and then let the salary received by a professor be determined by the years of service in his rank. If I may add a word of a general character in reference to university administration in this country, it would be: model our system as closely as possible, with the conditions existing in this country, after the German universities. Their present system of administration is the outgrowth of years, and in many cases of centuries, of experience. And what is the result? The finest system of higher education, beyond comparison, that the world has ever seen. Indeed, most of the productive men of science in this country, even to-day, have learned their lesson in the German universities, and transplanted research from Teutonic soil to this country. Such results as have been obtained in the German universities could scarcely have been reached under a system of administration that was seriously defective. It might be objected that the conditions in this country are fundamentally different with respect to higher education than those in Germany, and such an objection unfortunately contains a large element of truth. Nevertheless, we should profit by those greatest institutions of learning; adopting their system of administration as nearly as the existing conditions here will permit; and not learning the lesson of university administration all over again from the very beginning by experience. This is, I think, the real solution to the greatest problem in higher education in America to-day.

Your proposals concerning the organization of universities are absolutely in line with my own hopes. Unless the working staff of the university gets a chance to help in the shaping of broader ideals of university life their interest will always be low. The superstition of one-man power is one of the worst impediments to a wider training of a spirit of collaboration, the lack of which makes public life as well as university life an opportunistic medley. It is deplorable that to-day the man who can enlist the cooperation of some financial magnates is a most forcible element in setting the pace in university policies. With regard to detail, I suppose the closer we keep to the English and Scotch pattern the more likely are we to reach the result, on account of the anti-German feeling existing in many quarters. This would mean the adoption of having a chancellor of the university, whereas, personally, I should prefer to have a rotation of the rectorship among the faculties, similar to what exists in the Swiss universities.

I am in hearty sympathy with the underlying principles of your proposals. Taking them up separately: (1) The idea of a large corporation and of elective trustees is undoubtedly right. I think a chancellor essential. (2) The duties of the president are not given in your statement. It seems to me that the chairman of the senate might assume the responsibilities. (3) The idea of subdivision of the faculty into schools is right. I assume that in most universities the "college" would form a separate school. In which case, the collegiate faculty should, of course, divide and meet at times with the members of the various other schools. (4) I believe in the financial and educational autonomy of the schools. But in regard to nominations of professors, I see no advantage in the "board of advisers"; I think the senate should have the final authority. I doubt the need of giving veto power to the board of trustees. Each school should have the duty of initiating plans for new professorships. There may be certain "standard" or minimum salaries; but I do not believe uniformity is possible or indeed advisable. (5) I would emphasize the duties of the senate, and would, I think, allow the board of trustees to appoint from the faculty a certain number of members. Certainly the membership should be small, less than twenty. The chairman, elected for one year, subject to the approval of the board of trustees, might well perform the so-called duties of the president. You do not make any definite proposal concerning means of contract with the alumni and the public. There should be, I think, an office charged with this duty. At its head should be a most capable man, not a member of the faculty, who might be also the secretary of the senate.

SCIENTIFIC BOOKS

In Northern Mists: Arctic Exploration in Early Times. By Fridtjof Nansen. Translated by Arthur G. Chater. In two volumes. Frederick A. Stokes Company. $8.

These beautifully printed and lavishly illustrated volumes are most interesting, but the reader who turns to them solely for "arctic explorations in early times" will be surprised, for less than one fifth of the matter pertains to polar voyages. Dr. Nansen properly had misgivings when he said, "Many think that too much has been included here." Among such matter falls amber, tin, ship-building from 1,200 years B.C., and other similar and slightly related matter.

Marred though it is by discursive and heterogeneous treatment, the work is of historic value and literary interest. Most comprehensive in its scope of investigation, and in its wealth of assembled material, it will unquestionably prove of value to geographical students as a source whence can be drawn information of, and textual extracts from many rare and little-known works and manuscripts. Its extent and thoroughness may be surmised from the three hundred consulted volumes, and in a dozen languages, whose citations could not be verified under months of labor, let alone the judicial consideration of their pertinency and value.

For the general reader the volumes have value and interest along two lines especially, Greenland and cartography. It is gratifying to find brought together such extended details relative to the early exploration of Greenland by Europeans, and to the interrelated history of the Scandinavian colonization.

In cartography there are more than seventy maps reproduced, in whole or in part, those from the geographical works of the middle ages being the most interesting and valuable.

It is strange that the attractive and well-known woodcuts of Olaus Magnus were not reproduced from the original edition (Rome, 1555). One would have gained a much better idea of the landscapes of Greenland and of Iceland if there had been reproductions of the excellent available photographs made by the Danish officers, instead of the present drawings, which—artistic though they may be—utterly fail to convey clear and accurate conceptions of the polar world.

Neither in novel views nor in their relations to arctic explorations do the accounts of the voyages of Cabot and of the Portuguese merit publication herein. The rehabilitation of Pytheas, of 300 B.C., is ingenious, though much over-elaborated and qualified—necessarily.

The giving of about one sixth of the work to the much-disputed subject of Wineland the Good appears to little purpose. Dr. Nansen's views will not prove acceptable to all the authorities on this mooted subject, which is not finally decided.

Heterogeneous and negative as are Dr. Nansen's opinions that Wineland is a myth based on the Fortunate Isles, yet they are well-considered and merit close attention. His conclusions are briefly as follows: (1) Adam of Bremen is untrustworthy. (2) The oldest Icelandic authorities mention Lief Ericson unconnected with Wineland. (3–4) Lief's discovery is not mentioned until the 13th century, and definite statements as to Wineland only appear at the end of that century. (5) The Flateyjarbok narratives differ widely from the earlier. (6) The first saga contains only mythical and borrowed matter. (7–8) The Greek myths mention wild-growing vines and wheat in the Fortunate Isles. (9) The association of wine and wheat with North America is artificial. (10–15) Before the 11th century Ireland had myths of happy lands to the west in the ocean, thus affording a common basis for the sid-people of Ireland, the elf-people of Iceland, and the huldre-people of Norway. (16–17) The Norse name "*Vinland hit Gooa*" is a translation of "*Insulae Fortunatae.*" (18) The name of the inhabitants, Skraelings, indicates that Wineland was a fairy country. (19) Icelandic and Norse geography connecting Wineland with Africa, is evidence of its identity with the Fortunate Isles. (20) Though the saga of Eric the Red and the "*Groenlendinga-pattyr*" contain no reliable data as to the discovery of America by the Greenlanders, yet the mention of the arrival of voyagers from Markland in 1347, and other references, show that they must have reached the coast of America. (21) Hvitramanna-land is a mythical country, modified by christian beliefs. (22) "Finally, from the ancient Greeks to the Icelanders, Chinese and Japanese, we meet with similar myths about countries out in the ocean and voyages to them."

The intense patriotism of Dr. Nansen in pushing to the broadest possible extent the importance, if not almost universal claims of superiority for Norway in arctic explorations may be viewed as pardonable, though his views will not always gain acceptance.

In his general line of argument it may be said that similar methods by hostile critics would work havoc with many of his finely spun and vigorously advocated conclusions. It is to be regretted that so scholarly a work should not invariably display that fine spirit of judicial calmness, and considerate acceptance of the opposing views, so general in these days on subjects widely controverted. Argument is not made convincing, nor acceptable even, through describing the conclusions of other historical students and investigators as "pure guess work," "absurdity" or as "imaginativeness."

It is to be hoped that the distinguished author will soon contribute a work wherein arctic work shall be fully correlated and brought down to the conquest of the two poles.

A. W. GREELY

Cocoa and Chocolate. Their Chemistry and Manufacture. By R. WHYMPER. Philadelphia, P. Blakiston's Son & Co. Octavo. Pp. xii + 319 and index. $5.00.

This work, which does credit to author, printer and publisher, is a striking example of the development that characterizes present-day science. Not many years ago a few pages in a work on food production or food analysis would have been deemed sufficient for the subject.

The author brings to the consideration of the subject matter of the book not only experience and scientific judgment but an earnest interest in the cacao products and we can have but little doubt that he enjoys a cup of "cocoa," in which enjoyment the reviewer shares.

Brief but comprehensive chapters are given on the history of the introduction and use of cacao products, on the botany and nomenclature of the several preparations, after which the growth, manufacture and marketing are considered. A table shows comparison of the calories of cacao preparations with those of common food articles by which it appears that chocolate has three times the heat energy of an equal weight of hen's eggs and nearly double that of peas and bread. Of course, these comparisons, considered by themselves, will be quite misleading, as no account is taken of the relative cost of the articles—surely an important matter in these days—but also the fact must be borne in mind that in the free consumption of cacao-products a notable amount of an alkaloid is introduced while in standard foods no such ingestion occurs. Notwithstanding the high calories and even high protein content of cacao-products we should err in regarding them as more than beverages and confections.

We are informed that while *Theobroma cacao* is the principal source of cacao-products, several other species contribute a not important share. It is satisfactory to note that while commercial conditions necessitate the use of the term "cocoa" as a name for the marketed products, the author emphasizes the fact that the correct title is "cacao" and uses this when speaking of the raw materials and also the separated fat, which is (very properly) termed "cacao-butter." Incidentally another important point is noted, namely, that the oil from the fruit of the *Cocos nucifera* should be termed "coconut oil" and not, as is often done, "cocoanut oil." For thus aiding in correct orthography Mr. Whymper deserves thanks.

The methods of cultivation, ingathering and curing are given in great detail, illustrated with many fine full-page photogravures. The machinery employed in manufacturing the several commercial preparations is also illustrated and described. Of course, the cacao plant is subject to diseases, but it is specially interesting to note that in many places its successful cultivation requires the association of other trees for shade, and that these latter sometimes communicate their diseases to the cacao nut. In this connection it is worth pointing out that it has been long known that sandalwood trees do not thrive when grown by themselves, and it was supposed that this is due to need of shade, but it has lately been proved by the investigations in India that sandalwood is a partial root-parasite. In Trinidad a particular luguminous tree is so commonly used as a shade for cacao that it is known as "Mother of Cacao."

The food chemist will find in this work a vast amount of important and interesting technologic and analytic data. The commercial forms of "cocoa" and "chocolate" are fully explained both as to preparation, composition, analytic examination and adulteration. Over one hundred pages are devoted to these topics, and the bibliography, a summary of which is given separately, covers a very wide range.

No important typographic errors have been noted. On p. 65, the date for the reference to *Chem. Zeit.* should apparently be 1897, instead of 1887.

The book is a timely and valuable contribution to the literature of an important topic.

Henry Leffmann

SPECIAL ARTICLES

ELM LEAF CURL AND WOOLLY APHID OF THE APPLE

It was with considerable astonishment while working over some elm aphids several winters ago that I found that I was unable to separate on structural characters certain collections of *Schizoneura americana* (causing and inhabiting elm leaf curl) from certain collections of *Schizoneura lanigera* (the troublesome woolly aphid of the apple). It seemed absurd to suppose that a species under such constant observation as the woolly aphid of the apple could be masquerading on our elms all these years without biological evidence of the fact having been chanced upon long ago.

However, the guess based on structural evidence, wild as it seemed, was worth following up and field observations were made during the next seasons. Spring migrants were observed to desert the elm leaves in the early summer, and fall migrants to leave the apple branches in the fall, but no conclusive data as to the destination of either were obtained in the field. Both migrations covered a rather extended time and the situation was especially complicated by the continuous presence of apterous forms on the apple (either on branch or root) all the year and of "*rileyi*" on the trunks of young elms during the summer.

This past winter preparations for a migration test under control conditions were made by raising from seed young apple trees in a greenhouse safe from any possible infestation of the "woolly aphid."

This spring elm leaf curl was obtained from the south and the emerging winged forms were caged over apple seedlings while depositing their young. As a result, the progeny, a fine lot of nymphs that are growing along creases where the thin bark is scaling back, in the axils of the leaves and on exposed roots of the apple seedlings, covered by a typical flocculent white secretion, would be pronounced "woolly aphid of the apple" by any nursery inspector.

Though several kinks in the life cycle of this important species remain to be deciphered, the synonymy of *Schizoneura lanigera* Hausman (*S. americana* Riley) is the chief step in their solution. If the American species on elm is the same as the European species, our orchard pest, the woolly aphid, will revert to the name *Schizoneura ulmi* Linn.

Extended tests for the range of food plants of this species are under way, the reception of southern specimens adding about two months to the time possible for experimentation with the progeny of the spring migrants; which as they will be treated in detail later, need not be further indicated in this preliminary note.

Edith M. Patch

Maine Agricultural Experiment Station

A METHOD FOR THE REMOVAL OF THE TOXIC PROPERTIES FROM COTTONSEED MEAL
A PRELIMINARY REPORT

In our studies upon cottonseed meal intoxication we have used a method of treatment which has rendered the meal non-toxic to rabbits. We desire to test the treatment further with other meals and with other classes of animals, and we desire also, if these experiments result favorably to devise a method by which the treatment may be used upon a commercial scale. As it will take some time to carry out these experiments we wish to make this preliminary publication and to request others who are engaged in cottonseed meal studies to repeat our work so that the method may be thoroughly tested before being offered for use for commercial purposes.

Our experiment was as follows: 630 grams cottonseed meal previously extracted with gasoline were boiled on a water bath for two hours with 2 liters of alcohol to which had been added 40 c.c. of an aqueous solution containing 20 grams of NaOH, previous experiments having shown that this amount of NaOH was a little more than enough to combine with all the meal. The mass was filtered while hot, washed with hot alcohol and dried. 14.6 grams corresponding to 15 grams of meal were fed daily since March 18, 1912, to each of six rabbits averaging 1,992 grams in weight. These rabbits are all in good condition to-day (April 25, 1912) after 39 days' feeding, but have lost upon an average 134 grams. The feed eaten corresponds to 7.5 grams of cottonseed meal daily for each kilogram of initial weight of rabbit or a total of 292 grams per kilo for the 39 days.

Previous experiments with rabbits have shown that 7.7 grams of cottonseed meal fed daily per kilogram of initial weight of rabbit is fatal on an average after 13 days' feeding or a total of 100 grams per kilo of initial live weight. Our feed No. 189 has run for three times that period, the daily feed is practically the same and the total amount consumed is nearly three times as great. From this we conclude that the alkaline treatment very greatly diminishes if it does not entirely remove the toxic properties of the meal. This feed contains 1.70 per cent. of sodium instead of 0.04 per cent. as in the untreated meal. The beneficial effect of the alkaline treatment may be due to hydrolysis, or to the formation of a sodium salt, or to some other change not yet determined definitely.

We request that those who repeat our work follow the method closely, except to use 40 grams of NaOH instead of 20 grams.

We wish to acknowledge our obligation to Mr. R. S. Curtis, animal husbandman, and to

Dr. G. A. Roberts, veterinarian, both of this station, for their valuable assistance and cooperation.

W. A. Withers
B. J. Ray
North Carolina Agricultural
Experiment Station,
Raleigh, N. C.,
April 25, 1912

SOCIETIES AND ACADEMIES

THE ACADEMY OF SCIENCE OF ST. LOUIS

The Academy of Science of St. Louis met at the Academy building Monday evening, April 15, 1912, President Engler in the chair; an attendance of 65.

Professor A. S. Langsdorf, of Washington University, addressed the academy on "Transient Electrical Phenomena." The analogous conditions in various forms of mechanical systems and electrical circuits was shown and this was followed by a discussion of oscillating currents that may be produced in a transmission line. The necessity for guarding against excessive and dangerous voltages and currents arising from oscillation was pointed out, particular attention being given to the conditions obtaining in a transformer at the moment of switching such a device on to the live current. Finally the short circuit conditions in large alternating current generators was described so that dangerous rises of voltage accompanied by a rush of current could occur and the measures employed to prevent this condition were explained.

Dr. Charles H. Turner gave an illustrated account of "Results of Recent Experiments on the Homing of Ants." The results of the various investigators on the behavior of ants was divided into four groups and briefly discussed. About ten years ago the author began a series of experiments on ants and the main purpose of this paper was to compare the results obtained with those of Cornetz and Santsci. After a detailed comparison the final conclusion from all these experiments was summed up as follows: "Ants are much more than reflex machines; they are self-acting creatures guided by memories of past individual experience. These associative memories are usually complexes of sensations contributed by several different kinds of sense organs and include an awareness of distances and of direction."

Dr. Arthur E. Bostwick, of the St. Louis Public Library, read a paper on "Atomic Theories of Energy."

Professor Wm. H. Roever, of Washington University, exhibited and explained "A Mechanism for Illustrating Lines of Force."

The Academy of Science of St. Louis met at the Academy building Monday evening, May 6, 1912, President Engler in the chair.

Professor J. F. Abbott talked on "The Water Boatmen, an Unexplored Corner of the Insect World." After giving an account of the systematic position of the water boatmen, Professor Abbott discusses their development from the egg to maturity, a particularly interesting feature being the deposition of the eggs upon the bodies of crayfish.

Dr. Charles M. Gill gave an illustrated talk on "Recreation Studies in Estes Park, Colorado." The ascent of Long's Peak was described and some of the more interesting glaciers discussed. The necessity of protecting the natural conditions of Estes Park, for which a bill is now pending before congress, was referred to.

Mr. Frederick Hecker, of Kansas City, discussed the "Microscopical Study of Living Organisms and their Growth Rate," following it with a demonstration of the technique involved.

The Academy of Science of St. Louis met at the Academy building Monday evening, May 20, President Engler in the chair.

Dr. A. S. Pearse, of St. Louis University, gave an illustrated talk on "Fiddler Crabs" with particular reference to the color variation in the forms found at Manila, P. I.

Mr. Phil Rau read a paper on the life history of the "Devil Horse." After giving a detailed account of the anatomy of the devil horse, or praying mantis, the author described the character of the egg case, the emergence of the mantis from this case and the carnivorous habit of the insect. As the result of his series of experiments made to determine how and why the colors of the mantis change, Mr. Rau found that the green nymphs are capable of changing to a dark gray when the environment is dark and when once the gray color is acquired it is permanent despite any environmental conditions. Green insects in all probability remain green indefinitely if the environment is favorable to that color. The paper concluded with some observations regarding the mating habits of the mantis and a detailed description of the making of the egg case.

George T. Moore,
Corresponding Secretary

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ANNIVERSARY ADDRESS, IOWA ACADEMY OF SCIENCE[1]

There is an old and familiar phrase which reads: "To all to whom these presents may come, greeting." I remember how in youthful days this phrase struck me as of peculiar mold and how, without perhaps realizing its antiquity or history, I puzzled as to its full significance and the conditions which, in some distant era, must have given it birth. We need not now attempt to trace its lineage or discover how ancient ambassadors or messengers may have used it in their visits to friend or foe, but I like to fancy for the moment that I am commissioned to bring to you on this anniversary occasion the greetings and congratulations of the world of science. Certain I am that such greetings and congratulations must extend from organized science in general and especially from all societies of similar scope.

Science is essentially mutualistic and the success of one organization is the gratification of all—the triumphs and discoveries of one are shared with the many and the feeling of pride in the progress of the one may be shared without loss by sister organizations. As the discovery made in one branch of science may be the necessary foundation for the solution of some problem in another, so the contribution from one society may be the stepping stone to advancement in another. It is all hail then, greetings and felicitation and God-speed in the accomplishments of your future destiny.

The state academies of science, or socie-

[1] Delivered at the twenty-fifth anniversary meeting in Des Moines, Iowa, April 26, 1912.

ties of the scope of ours, are of comparatively recent origin, so that the achievements of the quarter century of activity and growth are well worthy of recognition. Such societies have their antecedents in the local academies formed by groups of scientific workers in various cities or limited communities, which again may doubtless be considered as an introduction from the old world, where academies of science under various names have been in active operation for a much longer period of time. Among the first and most notable which were organized in this country are the American Philosophical Society and the Academy of Natural Sciences of Philadelphia, the Brooklyn Academy of Arts and Sciences, the American Academy and the Boston Society of Natural History of Boston, and the St. Louis Academy of Science.

Such local societies were established for the association of scientific workers in centers containing a sufficient number to serve as a stimulus for such work and for a time at which ready communication between distant cities was not so convenient as at the present time. The organization of the state academies, however, seems to have occurred particularly in the central-western country and may be looked upon as resulting from the condition of scientific workers within the boundaries of these commonwealths. The scope of these academies has, however, taken on a somewhat different range, at least for many of them, since they have in many cases served as scientific advisers to the states in which they exist. This particular function of course makes the state boundary of special significance and is perhaps in itself a sufficient basis for the organization of such societies in every state. That very much can be accomplished by such a connection may be seen from the many different scientific activities which have been encouraged or stimulated by the societies or by the individual members under the incentive of associated work. For instance, the geological surveys, biological surveys, topographical surveys, and other enterprises dependent upon state support have in many cases had their origin and in many other cases received their support and encouragement from the state academies.

State academies exist in Wisconsin, Kansas, Iowa, Indiana, Minnesota, Nebraska, California, Ohio, Illinois, Michigan, Colorado, Utah, Oklahoma, Maryland and Tennessee. In some degree they measure the scientific activity of the states, naturally they should flourish in states of large area and less population where the isolation of scientific workers has been a special incentive to their organization. One of the first of these to be organized was the California Academy of Science, followed by the Maryland Academy and the Wisconsin Academy of Arts and Sciences, which latter seems to have been organized with distinct state faculties and state support from the start and with a remarkably full and valuable series of publications to its credit. While its scope is somewhat broader than some of the others so as to include historic and literary productions, so large a part of its work has centered on scientific problems of the state that it is to be counted one of the most fruitful of the state academies devoted to science.

The Kansas Academy of Science, organized in 1867, has been a very active society through all its career, and its reports published by the state constitute a most creditable contribution to the scientific papers of the state.

The Indiana Academy, organized 1885, and which celebrated its quarter-centennial with a notable meeting two years ago, has shown great activity, especially with reference to the problems of the state.

The Ohio Academy, with which I have been associated for a number of years, has enthusiastic annual meetings, publishes its own proceedings, has a research fund contributed by a friend, and has been instrumental in founding several projects of state-wide interest and importance. While its work has been mainly in biology and geology, its programs include papers on widely varied lines of study, and it has been of great service in promoting acquaintance and cordial feeling among the scientific workers of the state.

These few references to particular societies are given not because they are more important than others that might be named, but because they will serve to indicate the scope and sphere of the state organizations in science. They certainly amply justify the effort of the devoted members who have given so unstintedly of time and thought in the upbuilding of the societies and the enterprise they represent.

While the political boundaries of a state do not always best limit the activities of such a society, there is distinct reason for such sphere in the relation the academy may have to state problems of a scientific character. Such a society composed of representative students from various professions and positions may well constitute a useful advisory body for the legislative bodies in dealing with the problems requiring scientific attention, but in addition to this, the many problems that relate themselves naturally within state boundaries or can best be associated with public state enterprises, surveys, etc., give it a rational sphere. Perhaps the most emphatic basis, certainly one of the most forceful to the membership, is the opportunity for acquaintance, good fellowship and friendship among the workers in a common field. This alone would be ample reason for the time and effort given to the periodical meetings.

While these societies do not boast of monumental edifices, great pageantry or display, their place in the world of science is determined by the record of contribution to the world's knowledge and this recognition in their several spheres will be based on their service to the welfare of the communities in which they labor. That this service is a growing one and that its fruition in years to come will bring credit to all those who have labored in their promotion is, I believe, beyond doubt.

They are centers of research and research is the breath of life for science. New investigation and discovery are the essential to activity. This has been shown in every period of the world's history. Witness the stagnation of the middle ages, properly called the dark ages, when authority took the place of progressive research and the conquest of the unknown. As such centers of research the academies are factors in the advancement of learning, and so of the progress of the race. Every one is a force for betterment and speed the day when such forces are operative in every state of the nation.

Sometimes we may think there is an overproduction of scientific societies—especially when dues become payable—but while there may be some with no necessary mission, we can learn to discriminate and encourage those of merit. There is also, I think, less danger of degeneration in a number of fairly independent societies than in a too great centralization with the domination of small circles who happen to be in control.

This Iowa Academy was preceded by an earlier society, organized in 1875, and which held meetings up to 1884, when from the removal of some of its most active members and unfortunate disagreement between some of those remaining it ceased to exist. I recall, however, with much pleasure the meetings that I attended during the years 1876 to 1884, and the opportunity it afforded to become acquainted with the active scientific workers of the state. Professors Calvin, McBride and Hinrichs from the university, Todd from Tabor, Herrick from Grinnell, with Bessey, Fairchild and Macomber of Ames, Putnam of Davenport and Witter of Muscatine were among the active members in attendance at those meetings. It was at one of these early meetings (1876) that my first effort in the line of a scientific contribution was presented and while it appears to have been a very simple and crude affair it naturally marked an important step in my own interest in scientific work. I have always felt that it was regrettable that this earlier academy had to be abandoned, and it was not until after several sincere efforts to rejuvenate it that the conclusion was finally reached that this was impossible, and the only course left to organize on a new basis.

I shall not attempt here a review of the achievements of our academy. Time and the command of the details both forbid and this feature is to receive attention in another part of our program. I wish, however, to revert briefly to the early hopes of the society and to see in what degree its achievements have measured up to those early aspirations.

In the first annual address before the society, which I may confess here was delivered before a mere handful of scientific friends, I presented some ideas as to what I conceived to be the opportunity for the society and the lines of work desirable in the state. Digging up this buried and long-forgotten address, I have been interested to see in how many respects this forecast has been met and the ideas there advocated provided for in one way or another in the state's activities. Not that I would claim any special foresight or prophetic vision in the case nor that this address had any special weight in securing the results, but that it shows in some degree perhaps the sort of hopes and aspirations for which the members of the Academy stood in those early days.

For example, a geological survey was strongly urged and the organization which soon after followed and the splendid service of this survey to the state have amply justified the plea. A readjustment of the weather service was suggested and the successful combination of the state and government service which was accomplished a few years later and which has proved one of the most effective in the country, is our proof that the hope was not a vain one nor its accomplishment impracticable. The plea for a state museum for the preservation of our native fauna and flora has been met in part at least by the splendid start made in the collections gathered in the historical museum so ably organized by the lamented Charles Aldrich, and many phases of biological investigation have been provided for in the Experiment Station.

The academy volumes which have been published by the state for a number of years have become a distinct feature of the state's activities and are watched for eagerly each year. The record of achievement which they show embraces so many important facts concerning the natural history, geology and other scientific problems that the scientific literature of the state would seem meager without them.

One thing then urged and desired by many of the members seems not yet provided for, at least in fact, and that is a biological survey. This was included in the plan for a geological survey, and though it is specified in the act creating the survey the actual attention to this phase of the work has been, as all must realize, a very minor matter. No more, I grant, than has been the case in most states where similar conditions exist; no more, perhaps, than seems necessary from the important problems pressing for solution along geological lines. I submit, however, that it is hardly the proper thing to get a survey established with the support of two bodies of workers and then devote all the resources to one line of work, and this condition prevails in far too many states where the so-called geological and natural history surveys are doing little or no biological work, and often that little as a purely gratuitous service from devoted workers.

Speaking now as an outsider and viewing the matter from a distance it appears to me that here is one enterprise that this academy might make one of its pet projects. If a thorough and systematic biological survey can not be pushed forward under the present organization so as to secure accurate knowledge as to the biological resources of the state, then let the biological workers get together to secure provision for the work under some other form of organization.

But I should remember that I have not been invited here to give advice and I am too well aware of the energy with which the Iowa people can advance the projects in which they believe to feel that advice is needed.

On such an occasion as this it seems almost a necessity to attempt some review of the progress made in the lines of work for which we stand, but in addressing myself to this task I am more than ever impressed with the rapidity of this progress and my inability to discuss it. This survey applies more especially to the last quarter century, as this is the period most familiar to me, and of which I can speak most intelligently.

So many principles of fundamental importance in science have been discovered or elucidated during the quarter century that it makes a pretty full record if one makes the attempt to compass it. Among those of especial interest are the determinations concerning the kinetic theory of matter, the progress concerning certain phases of the theory of evolution, the newer aspects of the theories for cosmic evolution, the application of Mendel's law in the problems of heredity, the atomic theory of electricity, and of course numerous others which we can not stop to mention. In some of these there has been such a complete change of view that one who goes back to his school science of a quarter century ago must feel quite lost in the light of new discoveries or imagine himself to have been unconscious for a period and waked up in a new era.

There is perhaps no field or phase of science in which the change of attitude has been more prominent than in the application of science to the problems of every-day life. Science and human welfare, as represented in industry, in public health and sanitation, in the betterment of social conditions, are being linked closer and closer together and the progress in the past quarter century has been more rapid than in any other period of the world's history.

To review the different branches of applied science and to show the details of progress in each would be an impossible task for one person in a brief address and, moreover, much of it is an oft-repeated and familiar tale. We all know something of the marvelous strides in medicine and surgery, one of the most conspicuous fields of science in relation to human welfare, though I doubt if any of us outside the body of active workers in this particular field realize the revolutionary changes that have taken place in surgical methods and therapeutic agencies as a result of the application of scientific discoveries in the realm of physiology and biology. Bacteriology alone, which has had practically its entire development within the quarter century, has changed the whole basis of treatment in hosts of diseases and given an entirely new foundation for preventive medicine and sanitation. Still more recently protozoology has entered the field with a present record of many most serious diseases determined as of protozoan basis, and a promise of solution for many more that have baffled medical science for centuries.

In the field of industry the changes of the quarter century have been so enormous as to defy description, at least by one who has not followed the growth in detail. A complete metamorphosis, as a biologist might say, has occurred in many trades and manufacturing industries and practically all based on scientific discoveries and applications. Chemistry, physics, mechanics, biology, geology and other branches of science have contributed their share in this evolution.

In agriculture we see this process at present in one of its most active periods and we can only predict from rapidity of change what the future may bring. Enough, perhaps, to say that production is to be still further accelerated, farm conditions, both for greater production and better living, immeasurably improved and the basis of support for a denser population enlarged. Here, as in medicine, botany, zoology and bacteriology are playing a most important part.

Linked to these phases of human activity in most important manner is the problem of transportation, an activity perhaps more typical of the modern spirit than any other. Locomotion by water, by land and now by air, has been accelerated in a marvelous degree in the quarter century just passed. Twenty years ago I stood in a street in this city of Des Moines and watched a street parade, the most interesting feature of which, to me at least, was a horseless carriage driven by electricity, one of the very few up to that time that had actually been made to work. And for a number of years after that the automobile was in a strictly experimental stage. Now, well it is entirely unnecessary to mention motor boats or motor vehicles or even flying machines as of doubtful accomplishment. I doubt, however, if we fully realize the immense changes produced in our social status by the progress in rapid transit on water or on land for the last few years. As for the place of aerial navigation, that is yet to appear, but I have no doubt as to its practical application in human affairs. It can not displace present modes of travel or transportation, but will, I have no doubt, create a class of service for itself and doubtless one which will have a profound influence on human welfare.

Closely linked again is the question of rapid communication. Foreshadowed by the telegraph, electrical science has in recent years given us the telephone and the wireless as accomplished facts in communication, regardless of time and space. Thirty years ago, when the first commercial lines of telephone were being connected up, it was still looked upon largely as a toy. Very few, even of its most ardent promoters probably, had any conception of how it would alter the conditions of human life, or revolutionize methods of commerce and the relation of social centers, or of city to country. So swiftly and quietly has this come that I doubt if we fully realize the significance of it all. While there still remains to those of us who saw it come some remnant of wonder at the phenomenon, the coming generation accept it as a matter of course and chatter through the telephone apparently oblivious of the marvelous scientific achievement which put it at their service.

And so we might go on with other achievements of the recent years, the cotton picker, the trolley car, the gas engine, long-distance transmission of power and the moving picture, all of which would have been impossible but for scientific discoveries and their application. I desire, however, to take a little time for the achievements in my own more special field of work—that of entomological science. Not alone because of my greater familiarity with it or because it has been the field of my own labor, but in part because I am constrained to think that the actual progress in this field has not been appreciated, even among biological students, as fully as the facts may warrant.

While to say that economic entomology has been developed in the last quarter century would be putting it too strong, it is true that so large a part of the growth, both for the determination of the fundamental principles and for the application of these to special problems has occurred within this period that it is not unfair to claim it for this epoch.

Less than fifty years ago I was rapping potato vines over a tin pan to catch the potato beetles that were devastating the potato fields in Iowa. In fact, as far as I recall, this was my first entry into the field of economic entomology and I believe about my first financial income was derived from this sort of service. But it was a good many years afterward that methods of control for that pest based on knowledge of habits, life history and chemical poisons were an accomplished fact in economic entomology.

The warfare with the Colorado grasshopper, the cotton worm, the San José scale, the gipsy moth, browntail moth, cotton boll weevil and such old-time pests as the codling moth, chinch bug and Hessian fly have either been fought and more or less completely won within the last quarter century or so nearly within it as to form a part of its history.

One of the very striking lines of progress has been in the transportation of the parasitic enemies of injurious insects, a phase of economic work which had only just begun twenty-five years ago, and which has been practically developed within the last decade with special reference to the depredations of the gipsy moth and the browntail moth. While this mode of contest with injurious insects, especially those which are introduced is not as yet entirely past the experimental stage, so much encouragement has been derived from recent results that we must certainly look upon it as a very important phase of entomological investigation, and one from which we will almost certainly secure important results for certain pests. It may not be possible to duplicate in any case the phenomenal success attained in the control of the cottony-cushion scale in California, but the success with that species and the less perfect success in the case of others must at least point the way to further efforts, and we may expect that a certain number of important species may finally be controlled in this manner.

The methods for control for introduced species the spread of which may be retarded by quarantine or inspection have been developed entirely within the quarter century and the service rendered in this manner is beyond computation.

To a large extent, the content and method of economic entomology have been appropriated in other special fields. Especially is this true in horticulture, where the methods and results of entomological research are appropriated to such a degree that I doubt not many students fail to realize the incorporation. In medicine, also, while we still may speak of medical entomology, the relations to medical research have been so close that we may find difficulty in separating the doctor studying entomology from the entomologist investigating insects with reference to their medical aspects. The fact is that various fields have been opened up to a far greater extent than is possible for one man to follow and we have reached a stage of differentiation when to keep abreast of progress one must confine his effort to a limited part of the entomological field.

But a feature of the subject which I wish especially to emphasize is the attitude of science, or, to be more personal, the scientific worker toward the application of science in human affairs and for human welfare, that is, toward economic or applied science in all its phases.

The time was when probably the greatest efforts in invention and in the application of knowledge were devoted to engines of human destruction, and while this effort may have been a stimulus in the acquisition of knowledge, it could hardly be considered an influence for the promotion of the race.

Now, however, our boast is rather toward the progress in preservation and promotion of life. It is considered cause for glory that we can reduce the percentage of infant mortality, that we can check the spread of pestilence, that we can minimize the dangers of travel, cut down the property loss and the death list from fire or other disaster, and, in short, lengthen the span of human life and improve its opportunities for betterment and enjoyment. And, more significant perhaps, is the fact that such improvement is expected and in large degree made to apply to humanity as a unit, not to any individual or special class.

This attitude is the more conspicuous if we go back a few years to note the trend of scientific ideal. Read, for instance, the plea by Professor Rowland, the brilliant physicist, for devotion to pure science, given in 1885.

I remember how in my own experience scarce thirty years ago the venerable Dr. Hagen, doubtless the most profound student of entomology of the time if not of the century, made a most emphatic plea with me, with all the force of his German accent, not to go into economic entomology, but to give my effort to the pure science, "for the love of the science."

Now I believe that this attitude differed more in appearance than in fact, that the devotees of science, while some of them really did not care to have their discoveries made of any value to mankind, were really protesting against the commercializing of their scientific talent rather than the utilization of science for the good of humanity and often a plea simply for continuous drafts on original sources of knowledge instead of mere applications of knowledge gained. Certainly it is inconsistent with any reasonable desire for the acquisition of knowledge to deplore its use. Nor does it look strictly consistent for a person with this claim to sell his talent even to a university or a research institute for so much even as the moderate salaries that they usually afford.

But the attitude which I believe is becoming most dominant with scientists is that of the service of science to humanity at large, and the wish that beyond reasonable return for the work involved the profit should not be allowed to pile up for the benefit of a few.

What satisfaction is there in discovering a method by which to gain a double crop from the soil, to avoid loss from destructive agencies, or to double the capacity of human labor if the gain is all absorbed by an aggressive few and the scientist and the real producer are left with no betterment of condition.

Such absorption does too often occur and it is not much to be wondered at that the pessimistically inclined should question what profit there is in our boasted scientific progress if the advantages of it all are to be seized upon and appropriated by an inner circle who can. One of the most important problems of the age is to discover how the gains of scientific discovery may be equitably shared by all deserving members of society.

But such an occasion impels us to look forward as well as backward. What will the next quarter century of science reveal to us of the unknown, what problems of age-long study will have yielded their solution, what theories of to-day will have vanished and what will be the nature of those to take their place. For this we can simply say wait and see; we may be content to believe that progress must continue and I believe we may also say that in most lines this progress will be on the foundations already laid. For one, I have sufficient faith in the science of to-day to believe that we have reached a secure footing and that we may push forward with confidence that the structure we build will not be doomed to complete destruction, even if in some of its details the lines must be recast. At least one strong ground for effort is confidence in the truth and permanence of the structure on which we work and despite occasional voicings of dissent I would hold for faith in our own work.

When the next quarter century shall have passed and you celebrate another anniversary, as I have no doubt you will, for the academy is now so fully established that its lapse is unthinkable, you will plan a wider home-coming to include the many members who will have scattered farther still to the ends of the earth and I shall hope to meet many or all of you now here with many yet to come in that semicentenary of our birth. Mr. President, you need not for that occasion send me any invitation. I shall come without one if alive, as I hope to be, and if it is within the range of human possibility to do so. But whether here in flesh or not, I assure you I shall be in thought and spirit, for I shall carry with me from this day on not only my early love and devotion for the academy, but an abiding appreciation for the honor you have shown me in asking me to be present with you and for the cordial greetings from you all. For all this and for your kind indulgence in listening to these remarks, I most sincerely thank you.

Herbert Osborn
Ohio State University

ECONOMY IN UNIVERSITY ADMINISTRATION

I propose to consider briefly what I believe to be the most important factor in university economy, namely, the selection of the work which the university shall undertake.

Every important development depends upon two conditions: first, an adequate stock of energy; second, the selection of a few out of many possible channels through which that energy may produce its best results. A man will grow apples. His first concern is to secure a maximum amount of apple-producing energy in the form of well-bred stock, good soil, appropriate fertilizers, *et cetera*. His second concern is to save that energy from being wasted through weeds, through too many trees per acre, too many limbs upon the trees, or too many apples upon the limbs. His chief labor is to destroy alien growths, cut down redundant trees, cut off redundant limbs, and cull out redundant apples, so that the total apple-producing energy at his command may through a few channels produce the largest possible crop of the best possible apples. Wherever any first-rate result is to be secured, there must be these two conditions—adequate wealth of resources, but also severe selection. "To know how to omit," says Stevenson, "that is the whole of art."

The universities of the United States, taken as a whole, have had decided success within the past quarter century in meeting the first of these two conditions of development. The resources of the universities still fall far below the demands which our society makes upon them for service; but the absolute increase in university funds from private and public sources within that time has been very great. It is the belief of the writer that the universities have not been equally successful in meeting the second condition of development, and that the paramount need in our university administration is a severe selection of the channels through which our resources shall be expended.

The pressure toward expansion, toward the multiplication of colleges, schools, departments, subdepartments and individual courses, is constant. All those who help determine what the university shall undertake, trustees, president, heads of departments and individual members of the faculty, feel this pressure. Part of the pressure is meretricious, proceeding from unworthy rivalry between universities, or from unworthy rivalry between departments, or from other motives comparable to those which appear in the lower forms of commercial competition. Part of the pressure toward expansion is fundamental, proceeding from the deep social needs which have given rise to the university itself. There had to be an enormous expansion of the university's activities in comparison with what they were in 1875. The university exists to solve the problems which our complicated civilization must solve, and to train up men able to take the varied and difficult kinds of work required by that civilization. The so-called university of 1875 fell far short of doing either of these necessary things. The universities, taken together, must do both these things, must represent the whole of civilization as it is, and must attack every problem around the whole sphere of possible discoveries.

In order to do this, it was necessary, for one thing, that the universities should supplement the liberal arts college as it was in 1875 by the addition of new departments, schools and colleges, and for another, that each of the fundamental departments should undergo a corresponding expansion. A university department of chemistry, for example, does not exist in order to teach a little primary chemistry to sophomores. It exists to make the great underlying science of chemistry render the fullest possible service to mankind. A university department of chemistry, if properly supported and manned, tends to become a college in itself, with a budget and faculty comparable to that of the entire institution of forty years ago; and, in the best cases, everything done in the department is worth more to society than it costs. In many cases, the people have realized this quickly, and have met daring expansions made by the universities with means adequate for their support. In some cases, we have a university whose circle of activities approaches correspondence with the whole circle of services which society requires from learned men.

Unhappily, however, there is no university rich enough to carry out with success so vast a program. In truth, all the universities in the world are not now rich enough to do so. The richest university is, therefore, in peril of so multiplying the lines of its work that all the lines of its work shall be lowered in quality. It is very possible in this way for a university with a million or more of income to so scatter its resources that it can do nothing at all of first-rate quality. Whether a university be relatively rich or poor, its greatest mistake, financial and educational, is to indulge in a policy of expansions which fail to elicit their own support and which must, therefore, live by sapping the strength from established lines of work. This mistake may be made by the regents and the president in establishing new departments, schools or colleges, or by heads of departments in establishing new subdepartments or new sporadic courses, or by individual members of the faculty in undertaking indiscriminately wide lines of research. All these different forms of expansion come to the same thing if they involve spending money upon more things than can be done well.

The penalties which fall upon an institution which sins greatly in this respect are severe. The library suffers. The laboratories suffer. Salaries are kept down. The best men escape. Those who remain lose heart. The quality of everything done about the institution is lowered. The final calamity is that all this tends to bring to and establish in the institution a faculty of mediocre men. There is no known remedy for this calamity. If the institution grows suddenly rich, the way to progress is blocked by a group of men who can not be removed except by death, and whose mediocrity will pervade the institution for a generation. It is my belief that there is no American university which has not suffered more or less by expansions which have affected the quality of its work. It is certain that some of the universities with small incomes, in their effort to cover every field, have brought themselves in every field to a deplorable weakness. And it is certain that some among the universities with large incomes have, through the same error, grown large without having grown great.

By way of remedy, I venture to make four suggestions, two of which I have discussed at greater length in a former paper.

1. Heads of departments should, I believe, resist the constant temptation to multiply courses of elementary collegiate grade in order, as the phrase is, to cover the ground represented by the department. Instead of this policy, which tends toward waste and lowered efficiency, there should be severe selection of a narrow program of freshman-sophomore courses which shall represent typically the best things in that field. I believe that this second policy, carried out with intelligence by men who believe in it, means, for one thing, a radical economy in university resources, and, for another, greatly improved work. Even if there were no question of finance involved, the greatest pedagogical need in our colleges, as in all our schools, is the selection of a few essentials, so that students may master something intensively, and acquire the habit of mastery.

2. Heads of departments should resist the constant temptation to allow the multiplication of redundant junior-senior electives. Whenever a new elective of this grade is proposed, it should be confronted with two questions: (1) Is this course an essential part of the department's undergraduate program? (2) Is the course an essential part of a program of research which the department is prepared to undertake? If it serves neither of these two interests, it is the enemy of both. It should

be seen by all concerned that the sporadic elective is the greatest obstacle in the way of raising the salary of the man who gives it, as well as that of all his colleagues. For the per capita cost of such a course is nearly always very high, and can come from nowhere except the total available salary fund. The university must maintain many small classes in its advanced work. A class of one may fully justify itself to the university world and to the state which pays for it. But it is the interest, as well as the duty, of all concerned to see that every small class shall so justify itself.

3. Members of the graduate faculty should resist the temptation to provide equipment for research over wide ranges of their subjects. Instead of this, the professor who conducts research should plan a program of studies within which he and his students for a period of years shall work, and upon which his appropriations for graduate work shall be concentrated. No hard and fast line of definition can be drawn between these two policies. The broad difference between them is clear. Only the richest of our universities can do anything of quality in the way of research if the first policy is followed, and even in those cases there must be a great and unnecessary waste. On the other hand, any one of a score or more of our universities can successfully carry out the second policy. Let me give two out of many possible illustrative cases. Ten years ago a young scholar found himself in a university whose library was wholly inadequate for his studies. In presence of this situation he selected with deliberate care a program which he thought the university would be able to support. The trustees met his plan with warm approval. The total amount appropriated in the ten years was not great, but it proved sufficient for the purpose, for it enabled the man to write the best book within his special field, and incidentally it enabled him to accumulate the best working library for that field in the country, with two exceptions. The other case presents still more striking proof of the effectiveness of this policy, chiefly because it has been carried on for a longer time. In this case the man began twenty years ago. Within that time he and his advanced students have worked along the lines of two programs. He has had many graduate students, including a considerable number who have taken the doctor's degree under his direction. In both the special fields referred to he is recognized as the first authority in the world. He has accumulated for his work, so he states to me, the best library in the world. Yet the entire cost of this special library and of his laboratory equipment would be well within the means of any standard university in the country. If the same man had been led astray in the outset into browsing about over his interesting field, the whole of his splendid achievements would have been impossible.

Before I leave the subject of research, I wish to say that it is a great waste of resources to force the entire faculty into this form of work. Let each man do what he cares most for and can do best. If a man can write good prose or good poetry, or can train any of his students to do so, let us preserve that man and his work as precious, and not spoil all with the demand for orthodox doctors' theses. If a man finds out how to train freshmen in English composition, or how to develop a finer practise of honor among college men, let us count these achievements worth as much as if he had written a thesis upon what some one did with the same problems in England a hundred years ago.

4. The regents or trustees should be on guard against the constant temptation to multiply departments, schools and colleges

which are not justified. It is obvious, as I have already said, that the regents cannot follow any set rule of thumb in this their most important sphere of decisions. They may upon occasion err disastrously in either direction. What we hope from the regents is that they shall at all times stand resolutely for the maintenance of *quality*, and that they shall refuse to permit any student-catching or appropriation-catching expansion which can not justify itself in terms of fundamental social service. If the regents go astray at this point, whether through bad counsel or from their own initiative, nothing can save the university under their control from grave deterioration.

This paper should not conclude without reference to that university which in its early history went to the extreme in the concentration of its resources. I refer, of course, to Clark University. The trustees of that institution believed that they were not justified in founding one more New England college. They had not enough money to found a university where the usual round of departments should be adequately represented. Under the advice of G. Stanley Hall, they resolved upon the unprecedented plan of beginning a university with five departments. The result of this course was that in each one of those departments they secured a group of scholars unsurpassed in the country, if anywhere in the world. They had Whitman, Loeb, Michelson, Nef, Boas, Mall, Story, Bolza, Donaldson, and many other men who then had, or since have, won international standing. They had the only American scholar who has won the Nobel prize. The group of scholars at Clark and the work done there were at once recognized by the university world as of first-rate importance. A change of mind on the part of the founder and other conditions have modified the later history of Clark. Its example is one which no other university, certainly no state university, can follow in the extreme. But the history of Clark proves one thing of the utmost importance—that a university of relatively limited means may go into the front rank by sagacious concentration of its resources.

The members of this association realize well the difficulty of securing money for the university. But, in truth, it is not so difficult to get money as it is to spend it so as to have a minimum of waste and a maximum of efficiency. Our task is to discover and create the university for our century. The discovery demands statesmanlike discrimination between what is essential and what should be pruned away. The creation demands something still more difficult, for it demands a thousand decisions which cut across private interests. The institution which we actually create will depend upon the self-denial, the integrity and the courage with which members of the university day by day make these decisions.

William Lowe Bryan
Indiana University

LECTURES ON THE SMOKE PROBLEM

In the fall of 1911 the Department of Industrial Research of the University of Pittsburgh was provided by a Pittsburgh business man with funds for a thorough investigation of the smoke nuisance. At the present time the investigation is being conducted by a staff of twenty-five specialists, of whom seven are giving their entire attention to this task. Some of these men are studying the effect of smoke and soot on the atmosphere, on the weather, on plant life, on buildings, on the public health; some are investigating the economic damage done by smoke and soot; others are making a detailed study of the mechanical devices for preventing or abating smoke; and still others are inquiring into the chemistry and physics of smoke and soot, into the laws concerning the smoke nuisance, and into the history of the subject as a whole.

Recognizing the interest in the smoke problem manifested by a large number of American cities, and in response to inquiries that have been made, the department announces that the members of its staff are prepared to lecture on the following phases of this problem:

1. The Smoke Nuisance (a general presentation of the main phases of the subject).
2. Smoke and the Public Health.
3. Smoke and the Cost of Living.
4. Smoke and Plant Life.
5. Methods and Means of Smoke Abatement.
6. The Effect of Smoke on Buildings and Building Materials.
7. The Psychology of Smoke.
8. The Smoke Nuisance and the Housekeeper.

R. C. Benner
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University of Pittsburgh

A SCIENCE LIBRARY FOR CHILDREN

In association with the educational work which the Chicago Academy of Sciences has been conducting during the past few years a strong demand has arisen or a Children's Library and Reading Room. In response to this demand the trustees of the academy have furnished one of the rooms in the museum as a Children's Library and about seven hundred books have now been selected as a nucleus. Appropriate periodicals and a picture collection, in part for exhibition on the bulletin board and in part for study at the tables, will also be included. Stereoscopic views have been selected for their importance in geographic studies of foreign lands and for illustrating the agricultural and industrial activities of various parts of the world.

It is proposed to make this a carefully selected library of books suitable for children to read. A few of the books are of a somewhat technical nature, although most of them are in non-technical language. A few biographies of the great scientists, several historical sketches of the progress in pure and applied science, stories based, in part at least, on natural history studies and accounts of explorations which are instructive along scientific lines have been selected. Miss Mary A. Hardman, a member of the academy staff who has been offering courses of instruction to children at the academy during the last two years, has been appointed librarian. This Children's Library will be open to the public on and after August 5, 1912.

SCIENTIFIC NOTES AND NEWS

Among the degrees conferred by the University of Michigan at its recent celebration was the doctorate of laws on Dr. William H. Howell, professor of physiology at the Johns Hopkins University, and the doctorate of science on Dr. John J. Abel, professor of pharmacology.

At the annual commencement of Lehigh University, the honorary degree of doctor of laws was conferred upon Charles Leander Doolittle, professor of astronomy and director of the Flower Astronomical Observatory of the University of Pennsylvania.

Dr. Harvey W. Wiley received the degree of doctor of science from Lafayette College.

Dr. Henry Prentiss Armsby, director of the Institute of Animal Nutrition of the Pennsylvania State College, has been elected a foreign member of the Royal Academy of Agriculture of Sweden.

A banquet in honor of Dr. J. A. Witherspoon, president elect of the American Medical Association, was given under the auspices of the Nashville Academy of Medicine and the Nashville Board of Trade, on July 3.

Three portraits were presented to the University of Pennsylvania at its recent commencement: one of Provost Edgar F. Smith, the gift of the class of 1902 college, painted by H. H. Breckenridge; one of the late Professor Henry W. Spangler, the gift of alumni and students of the mechanical and electrical engineering departments, painted by M. H. Kevorkian; one of the late Professor Joseph Leidy, the gift of his friends, painted by A. P. S. Haeseler.

Dr. W. M. Davis has retired from the Sturgis Hooper professorship of geology at

Harvard University. He will continue to reside at Cambridge. Professor R. A. Daly, of the Massachusetts Institute of Technology, has been appointed to the chair vacant by the retirement of Professor Davis.

Professor Morton Prince has retired from the active duties of the chair of neurology in Tufts College Medical School, and becomes professor emeritus. He is succeeded by Professor J. J. Thomas, now assistant professor of neurology.

After thirty years of distinguished service in the University of California, Edward J. Wickson, professor of agriculture and director of the Agricultural Experiment Station, has been granted a year's leave of absence, which he will spend in Europe. At its expiration he will be entitled to claim a retiring allowance under the terms of the Carnegie Foundation.

Oswald Schreiner, Ph.D., and Elbert C. Lathrop, A.B., have been awarded the Edward Longstreth medal of merit of the Franklin Institute, Philadelphia, for their paper on "The Distribution of Organic Constituents in Soils" appearing in the August, 1911, issue of the *Journal* of the Franklin Institute, "a comprehensive account of important recent researches in agricultural chemistry."

The Livingstone gold medal of the Royal Scottish Geographical Society has been awarded to Captain Roald Amundsen for his geographical discoveries on his recent expedition to the south pole.

Mr. James Murray has been awarded the Neill prize by the Royal Society of Edinburgh for his papers on the Rotifera and Tardigrada.

Dr. H. H. Rusby, dean of the College of Pharmacy of Columbia University, New York, has resigned to establish a pharmacognostical laboratory in the city.

Professor Francis Carter Wood has been appointed director of cancer research under the George Crocker Research Fund of Columbia University.

Mr. Jerome D. Greene, general manager of the Rockefeller Institute for Medical Research, has resigned that position to enter the office of Mr. John D. Rockefeller, where he will be a member of the staff in charge of Mr. Rockefeller's business and philanthropic interests. Mr. Greene will continue as a trustee his connection with the Rockefeller Institute for Medical Research. Mr. Henry James, Jr., of Cambridge, Mass., has been appointed to succeed Mr. Greene in the management of the Rockefeller Institute. He is a graduate of Harvard College, in the class of 1899, and of the Harvard Law School in 1904, since when he has been engaged in the practise of law in Boston. He is a son of the late Professor William James.

Mrs. Mary Schenck Woolman, professor of domestic arts in Teachers College, Columbia University, has been elected president of the Women's Educational and Industrial Union.

Mr. Edgar A. Doll has been appointed associate psychologist in the department of research of the Vineland Training School, Vineland, N. J.

President Howe, of the Case School of Applied Science, has been given a year's leave of absence for the purpose of rest and recuperation. Dr. F. M. Comstock, professor of drawing and descriptive geometry and senior member of the faculty, will be the acting president during the next college year.

President R. C. Maclaurin, of the Massachusetts Institute of Technology, has gone to Europe, intending to visit the technological schools of Great Britain and the continent with reference to the plans for the new buildings of the Massachusetts Institute.

Dr. L. O. Howard has been appointed as a delegate from the Entomological Society of Washington to the second International Congress of Entomology to be held in Oxford this coming August.

Professor O. D. Kellogg, of the University of Missouri, is on leave of absence in Göttingen. He will attend the meeting of the International Congress of Mathematicians at Cambridge, England, and of the British Association for the Advancement of Science at Dundee, Scotland.

Professor Frederick H. Safford, of the University of Pennsylvania, has sailed for Europe and will attend the International Congress of Mathematicians at Cambridge.

Professor George C. Whipple, Mr. M. C. Whipple and Dr. J. W. M. Bunker, of Harvard University, are making a sanitary survey of Lake Ontario near the mouth of the Genesee River, in order to ascertain the effect of the sewage of the city of Rochester, N. Y., on the river and lake.

Frederick Haynes Newell, director of the United States Reclamation Service, delivered the commencement address at the Case School of Applied Science on May 29, his subject being "The Engineer in Public Service." At the close of the address the honorary degree of doctor of engineering was conferred upon him.

Dr. Joseph Jastrow, professor of psychology in the University of Wisconsin, has given three lectures on "The Sensibilities," "The Emotions" and "The Appraisal of Human Qualities" at the summer session of the University of California.

Dr. E. F. Bashford, director of the Imperial Cancer Research Fund of London, has accepted an invitation to deliver the Middleton-Goldsmith lectures of the New York Pathological Society next October.

Mr. R. W. C. Shelford, known for his work in entomology, formerly connected with the Oxford Museum, died on June 22, aged thirty-nine years.

Dr. Ferdinand Zirkel, emeritus professor of mineralogy at Leipzig and eminent for his contributions to this science, died on June 12, aged seventy-four years.

Dr. Ernst Schulze, professor of agricultural chemistry at the Zurich Technological Institute, has died at the age of seventy-two years.

Professor Charles André, director of the Lyons Observatory, well known for his astronomical publications, died on June 6, aged seventy years.

Under the will of the late Lord Wandsworth, a sum of £10,000 was bequeathed to Sir William Bennett, to be applied by him at his discretion for the promotion of medical research. Sir William has now decided to entrust the administration of the legacy to the London School of Tropical Medicine, under conditions which include the establishment of a research scholarship.

The organization of the Canadian National Museum has recently taken a new impetus, due to the completion of its home, the Victoria Memorial Museum building at Ottawa. Lawrence M. Lambe, representing paleontology; Harlan I. Smith, representing anthropology; Percy A. Tavernier, representing zoology; Robert A. A. Johnston, representing mineralogy, and Reginald W. Brock, director, have been elected as the executive committee of the museum staff, Mr. Johnston serving as secretary. Several expeditions are in the field. Research work is also being carried on in the museum and popular educational work is not being neglected.

The agricultural demonstration train, which the University of California sends out yearly, through the cooperation of the Southern Pacific Company, in the year just completed was visited by more than 102,000 persons, a gain of 24,000 over the previous year. It has proved useful in bringing to the attention of farmers improved agricultural methods and sources of information and aid in farming problems.

The United States Weather Bureau has changed the cooperative station at the North Dakota State University to a special meteorological station. As such, it is known as the Grand Forks station. It is closely affiliated in its work with the university's department of geology with Assistant Professor Howard E. Simpson in charge as special meteorological observer, the work being carried on as a part of the geographical work of that department. A complete meteorological equipment is furnished by the United States Weather Bureau. Constant records are kept of temperature, pressure, wind velocity and direction, sunshine and rainfall. Regular observations are made twice daily, at seven o'clock, morning and evening. The morning observations are telegraphed to St. Paul, where they enter a circuit reaching all important cities between Winnipeg, New York and Washington. The evening observations are reported monthly and are used in the compilation of climatological data.

THE production of anthracite in Pennsylvania in 1911, according to a statement just issued by Statistician E. W. Parker, of the United States Geological Survey, broke all previous records, exceeding the previous maximum output in 1907 by 4,700,000 long tons. The complete returns to the Survey show a production in 1911 of 80,732,015 long tons, valued at $174,852,843. This was an increase over the 1910 output of 5,298,767 long tons in quantity and $14,577,541 in value. In this increased activity and augmented production in 1911 the anthracite industry was in marked contrast to the bituminous industry, which showed decreases throughout most of the mining regions. Moreover, in most of the bituminous districts prices were generally lower, whereas the average price of anthracite in 1911 was 5 cents a ton higher than in 1910. Prices for the domestic sizes remained the same, but greater returns were received from pea coal and the smaller sizes. The greater production of anthracite in 1911 was probably due to increased activity in anticipation of a possible coal strike in April. However, the extremely severe weather of the winter practically exhausted any accumulated coal before the termination of the three-year period of wage agreements on March 31, 1912. It is an interesting fact, showing the highly organized condition of the anthracite industry—the so-called coal trust—that whereas in former years there was enormous mine waste in this industry, nowadays practically everything mined is utilized. Formerly enormous quantities of small coal and coal dust were thrown on to the waste heap, but now such "waste" is sold as it is mined, and the culm piles are being reworked. In 1911 the recovery from the culm piles and the smaller sizes obtained from the freshly mined coal constituted over 40 per cent. of the total quantity of anthracite marketed.

IN the early part of the year 1911, while engaged in the Smithsonian Biological Survey of the Canal Zone, and the adjacent parts of Panama, Mr. E. A. Goldman made a collection of 368 mammals. This collection, representing between 40 and 50 genera, includes 12 new species and sub-species, of which descriptions have just been published by Mr. Goldman (Smithsonian Miscellaneous Collections, No. 2073) in advance of the general report on mammals of this region. Nine of the new forms are from the Canal Zone, and the others were collected by the author when he was on a trip to the mountains near the headwaters of the Chagres River, Panama, in March, 1911. The new animals include: two opossums from near Gatun; two squirrels, of which one is known as a pigmy squirrel; four rice-rats; a yoke-tooth rat, which was found to be one of the most abundant rats in the grassy clearings of the Canal Zone; three spiny rats, including one known as an octodont, and named after Colonel George W. Goethals, U.S.A., chairman and chief engineer of the Isthmian Canal Commission. Among the birds collected by Mr. Goldman, while engaged on this survey, there are two new species of nun birds. These are described by Mr. E. W. Nelson, of the Department of Agriculture, Biological Survey, in a pamphlet published by the Smithsonian Institution, which forms the seventh paper on the results of this survey.

THE statistics of births and deaths in the German empire during 1911 show for Prussia an excess of births over deaths of 490,333, as compared with 581,465 in 1910. In Bavaria, where the returns have just been issued, the excess of births over deaths was 73,656, as compared with 84,682 in 1910. Thus the falling off in the growth of the population in Prussia and Bavaria together was more than 100,000. The Prussian ministry of the interior has issued a rescript to the provincial governors requiring them to obtain information from doctors, clergy, teachers, lawyers and others regarding the cause of the fall in the birth rate. The main questions are whether the limitation of families is intentional and, if so, what are the principal social and economic causes, and whether the birth rate is falling among the working as well as among the middle classes.

The production of salt in the United States in 1911 was 31,183,968 barrels of 280 pounds each, valued at $8,345,692, according to W. C. Phalen, of the United States Geological Survey, in a report on salt and bromine, just issued as an advance chapter from "Mineral Resources for 1911." This is an increase compared with 1910 of 878,312 barrels in quantity and $445,348 in value. In addition to the domestic production 1,014,926 barrels of salt was imported. This importation was partly balanced by the exports, 349,092 barrels, leaving an excess of imports over exports of 665,834 barrels. The United States is amply able, according to Mr. Phalen, to supply all the domestic demands, as the capacity of the active mines and plants is largely in excess of the present output. Moreover, there are many plants now idle that could easily resume operations should conditions warrant.

UNIVERSITY AND EDUCATIONAL NEWS

The Massachusetts Institute of Technology has received from Mr. Theodore N. Vail, president of the American Telephone and Telegraph Company, a gift of the valuable library on electricity and engineering of the late George Edward Dering, of England. The library is valued at about $100,000, and Mr. Vail has made an additional gift for its maintenance.

The estate of the late Dr. Francis Bacon is larger than had been anticipated, and the value of his bequest to Yale University will, it is said, reach $500,000, of which about $300,000 goes to the library, and $200,000 to the college and the Sheffield Scientific School for the assistance of students.

By the death of the widow of the late R. N. Carson, of Philadelphia, the sum of six million dollars bequeathed by him to establish the Carson College for Orphan Girls, is released for this purpose.

There are in course of construction at the University of Missouri a building for the department of physics at a cost of $100,000 and another for the department of chemistry, mainly for agricultural chemistry, at a cost of $60,000. The latter building has been named Schweitzer Hall in memory of Professor Paul Schweitzer who was for nearly forty years connected with the department.

The Educational Fund Commission, to whom has been intrusted the interest of a quarter of a million dollars for the purpose of sending selected teachers of the public schools of Pittsburgh for summer studies, has this year arranged to send

33 teachers to Columbia University,
30 teachers to Carnegie Institute of Technology,
19 teachers to Chautauqua Summer School,
14 teachers to Harvard University,
6 teachers to Cornell University,
5 teachers to University of Pittsburgh,
4 teachers to University of Pennsylvania,
4 teachers to University of Colorado,
3 teachers to Vineland Training School, Vineland, N. J.,
2 teachers to School for Atypical Children, Plainfield, N. J.
2 teachers to Pennsylvania State College,
1 teacher to Dartmouth,
1 teacher to University of Chicago.

Three hundred and twenty-nine teachers have now enjoyed the benefit of this fund, given by an anonymous donor, and it has been productive of such excellent results toward greater efficiency in our schools that the commission has already arranged to send quite a large contingent in the summer of 1913. An efficient and helpful vocational bureau has also been organized by the commission.

The Rev. Stephen Morrell Newman has been elected president of Howard University to succeed Dr. William P. Thirkield, who has become the Methodist Episcopal bishop of the diocese of New Orleans.

Dr. William Leslie Hooper, professor of electrical engineering, has been appointed acting president of Tufts College.

Dr. John Zeleny, professor of physics, has been appointed acting dean of the Graduate School for the coming year, at the University of Minnesota.

The board of trustees of Colgate University has created a new office, that of vice-president of the university, and has elected Dr. Melbourne Stuart Read to the office. Dr. Read is professor of psychology and has been secretary of the university for several years.

Mr. F. R. Marshall, now of the Ohio State University, has accepted the chair of agricultural industries in the University of California. Among appointments to agricultural instructorships are those of James Koeber, from Oregon Agricultural College, in farm mechanics, and William H. Arnold, in chemistry and botany, both men at the university farm; W. F. Gericke, from Iowa State College of Agriculture, and Paul S. Burgess, from Illinois, in soils, and Ralph H. Taylor, a University of California graduate, in horticulture. Giovanni Barovetto and A. C. Way are appointed to aid in the university's investigations for improving methods in grape growing, wine-making and the raisin industry; J. D. Denny to aid in improving the varieties of wheat, barley and other cereals grown in California; R. C. d'Erlach to help with the inspection of commercial fertilizers, and Meredith R. Miller, to aid in similar inspection of insecticides. Walter W. Bonns has been appointed plant physiologist at the Riverside Citrus Experiment Station. Two promotions are of William B. Herms to be assistant professor of applied parasitology, and W. G. Hummel to be assistant professor of agricultural education.

The New York State College of Forestry at Syracuse University announces the personnel of its staff in the work of instruction, investigation and demonstration as follows: Dean Hugh P. Baker, M.F. (Yale, '04), D.Œc. (Munich, '10), is director of the college and professor of silviculture. Dean Baker assumed his duties on April 1, coming from the directorship of the department of forestry at Pennsylvania State College. Frank F. Moon, B.A. (Amherst, '01), M.F. (Yale, '09), resigns an associate professorship of forestry at Massachusetts Agricultural College to become professor of forest engineering at Syracuse. Earlier, Professor Moon was forester of Highlands of Hudson Forest Reservation for the New York State Forest, Fish and Game Commission. Philip T. Collidge, graduate of Harvard College and of Harvard Forest School, becomes professor of forestry and director of the ranger school, which will be a part of the College of Forestry operating on recently acquired lands at Wanakena on Cranberry Lake. Professor Collidge resigns the directorship of the Colorado College of Forestry at Colorado Springs and of the Ranger School at Woodland Park, Colo., to take up this work. Nelson C. Brown, B.A. (Yale, '06), M.F. ('08), comes after an extended experience in the forest service and as assistant professor of forestry in Iowa State College to be assistant professor of forest utilization. John W. Stephen, B.A. (Michigan) and M.F. ('07), becomes assistant professor of silviculture, resigning for this purpose his relation as state forester with the New York State Conservation Commission. Edwin F. McCarthy, B.Sc. and M.F. (Michigan, '11), has served during the past year and continues as assistant professor of forestry, having especially the work in forest technology.

At the University of Illinois, Dr. Lotus D. Kaufman, at present supervisor of the training school of the Eastern Illinois Normal School at Charleston, has been appointed professor of education, and Dr. W. E. Burge, now of the Johns Hopkins University, assistant professor of physiology.

Dr. Arthur I. Kendall, of the department of preventive medicine and hygiene, Harvard Medical School, has been appointed professor of bacteriology at Northwestern University. Dr. Harold L. Amoss, of the same department, has been appointed assistant in bacteriology and pathology at the Rockefeller Institute.

Dr. David Vance Guthrie has been promoted to be professor of physics and astronomy at the Louisiana State University.

Dr. Ernest Anderson, research instructor in chemistry at the University of Chicago since 1909, has been appointed assistant professor of general and physical chemistry at the Massachusetts Agricultural College, Amherst, Mass.

James A. Gibson, instructor in analytical chemistry at the University of Missouri, has been promoted to be assistant professor.

Dr. Geo. I. Adams has been appointed professor of geology in the Pei Yang University at Tientsin, China, and sailed from San Francisco on July 12.

Dr. E. E. Glynn has been appointed to the George Holt professorship of pathology at Liverpool, vacant by the death of Sir Rubert Boyce. Dr. Glynn has for some years held the post of lecturer in clinical pathology in the university.

DISCUSSION AND CORRESPONDENCE

THE MISUSE OF THE TERM "MELANIN"

Inasmuch as there has recently been a plea for a more exact nomenclature in genetics, it may not be amiss to ask for a more exact terminology in some divisions of bio-chemistry. It is but natural that we should think of a substance in the terms of its most prominent trait, and that whenever we see that trait we should associate it with the substance. It has thus come to pass that all substances which are dark in color and presumably "indestructible" have been termed "melanins." This terminology has nothing to commend it and it often leads to great confusion. To one who has been endeavoring to arrange the literature of the animal pigments the misuse of the term "melanin" has caused an immense amount of unnecessary reading.

All bio-chemical text-books define melanin in more or less the same language "amorphous black or brown pigments . . . which occur in the skin, hair, epithelium cells of the retina, in certain pathological formations, and in blood and urine in disease."[1]

Among those who do not use the term "melanin" in its true meaning are a large number of chemists. In nearly every chemical journal we may find in the tables of the decomposition products of protein hydrolysis, a certain amount of "melanin" or "melanin nitrogen." It has long been known that when proteins are heated with mineral acids a black residue is produced which is insoluble in mineral acids, and *because it is black* it has been called "melanin." It may, or it may not, be related to the true melanin; there is at present absolutely no proof on either side; *but until it is shown to be related to the melanins in more ways than color or solubility, it should not be confused with the true animal pigments.* Whenever it is shown that the structure of the molecule of these products is essentially the same as that of the melanins then, and not until then, should they be classed with the melanins. In order to prevent the confusion which arises from this terminology I propose that we substitute for the "melanin" and "melanin nitrogen" of protein hydrolysis the terms proposed by Osborne, *"humin"* or *"humin nitrogen."*

There are some chemists and many biologists who contend that the production of this black humin by the acid hydrolysis of proteins, indicates that the true melanins have an origin in the proteins. There is no evidence excepting the fact that humins are black and look like melanins. Cane sugar, when boiled with hydrochloric acid produces black humins, which are indistinguishable, except for the absence of nitrogen, from the humins of protein decomposition. Indeed, many of the protein humins may originate in the carbohydrate groups which some proteins carry. In all probability the formation of humins from proteins is the same sort of a reaction as the formation of the black products from sugar (*i. e.,* dehydration), and in the latter case there can be no doubt that the product is not a melanin.

Piettre[2] and myself[3] have isolated pigments

[1] Hammarstein-Mandel, "Text-book of Physiological Chemistry," Wiley & Sons, 1911, p. 792.

[2] *C. R. Acad. Sci.*, 153, p. 782.

[3] *J. Biol. Chem.*, 8, p. 341; *Biochem. Bull.*, 1, p. 207; *Bull. Soc. Chim.* (4), 11, p. 498.

which contain a protein residue, and Dyson,[4] has secured histological evidence which supports the belief that the mother-substance of the melanins is a protein. From my "melanoprotein" (*i. e.*, melanin containing the protein residue) I split off the pigment portion by a short boiling with acid, and obtained a nearly clear solution of amino acids and polypeptides. *By a longer boiling of these amino acids and polypeptides with hydrochloric acid, I obtained a considerable amount of humin.* In this instance both a melanin and humin were obtained from the same protein and are, therefore, very probably not identical. If humin is substituted for melanin in referring to the products of protein hydrolysis, there will be less danger of confusing those who are not chemists, and who are accustomed to scientific terms which have a definite meaning.

A second instance of *possible* misuse[5] of the term occurs in a recent article in Science (N. S., 35, p. 765). In speaking of the coat-colors of cow-peas Dr. Spillman states that "breeding experiments lead me to think that buff, brown and black were pigments related to melanin." Just how they were related chemically is not stated, but presumably it is by color and solubility, but as seen in the case of humin these are no criterion. Inasmuch as melanins are everywhere defined as *animal pigments*, or *pigments of animal origin*, it is as impossible for a melanin to appear in the vegetable kingdom as for the coat color of a rabbit to be due to anthrocyan. It would be far better to coin a new term for these plant pigments, and reserve melanin for *those dark pigments, which occur normally or pathologically, in the animal body, skin, hair or feathers.*

Ross Aiken Gortner

Cold Spring Harbor, N. Y.,
June 19, 1912

[4] *J. Path. and Bact.*, 15, p. 298.

[5] Dr. Spillman does not say these pigments are melanins, but that they are "related to the melanins." Dr. Mann, in a later note (Science, N. S., XXXV., p. 1004), does state that a yellow or brassy-brown pigment and an intense black pigment are melanins.

"PRONOUNCED GĒN"

To the Editor of Science: One of your correspondents, Dr. G. H. Shull, discussing in Science for May 24, 1912, the spelling and pronunciation of the word *gene*, used by writers on genetics, says that it is "pronounced gēn."

This is a good example of the dilemma in which men of science are placed. They must use language, they must translate and transliterate language, they must concern themselves endlessly with nomenclature, they must strive to change nomenclature or strive to prevent any change. And they must at times mention pronunciations, if only to object to them. Sometimes they seriously wish to convey a pronunciation on paper to their intelligent readers. And here is a case. Dr. Shull, a trained man of science, writes to the intelligent readers of Science, and says that a certain artificial word is "pronounced gēn."

And what does that mean? It means one of two, three or four or more possible pronunciations. The reader has to *guess* what pronunciation is intended. In other words, a man of science, writing in a journal of science, about an elementary matter, completely fails to accomplish his purpose.

Why? Because some orthodox men of science object to any accurate indication in print of the sounds of the human voice; because they object to any representation of sounds that is not contained in certain traditional spelling-books and dictionaries (that is, in certain stereotype plates owned by certain dealers in printed ware); because they will not give a hearing to the men of science who understand the subject; because they close their minds and their journals to science itself, when it mentions language. The Jaspers of science will not listen to the astronomers. "The sun do move," and we won't hear another word! And so our real men of science, when they wish to state facts of language, must express their meaning imperfectly or ambiguously, or else keep silence. But silence also is ambiguous.

How long is this condition to continue? How long will the controlling men of science oppose the introduction into science of a correct and intelligible way of indicating the sounds of the human voice? How long will the American men of science who control scientific societies and scientific institutions and scientific journals, ignore or suppress the proposals of philological scholars to provide a definite system of indicating the sounds of the English language? How long will they oppose the movement to bring about a regulation of English spelling, so that English words may be spelt correctly and intelligibly, and so that a given man of science, in a journal devoted to science, and bearing the name of SCIENCE may present a simple idea, in simple letters, in a sure and certain way? How long? Ask our respected friends President X and Professor Y and Dr. Z, Editor P and Director Q, who sit at the gates of science, and scrutinize the tickets, and exclude every man who does not spell according to their Mohammedan way. In the name of the Prophet, phigs!

In the meantime the leaders in science will be writing in SCIENCE statements about language that are in fact futile, because, as we lawyers say, they are "void for uncertainty."

Of course I know, and you know, Mr. Editor, what Dr. Shull means when he says "pronounced gēn"; but we know it by a process of inference, and by a course of special study. No one else can tell what he means, except through the same process. The man of science wishes to be clear, but his colleagues won't let him. In the name of the Prophet, phigs!

CHARLES P. G. SCOTT
YONKERS, N. Y.,
June 24, 1912

FORMATION OF SPURRED FLOWERS IN HYBRID CALCEOLARIAS

WEBBER[1] refers to hybridization as the apparent causal agent in the development of a marked spur or horn on the lip of a hybrid *Calceolaria*. Characters apparently new are said to appear rather commonly in hybrids and the idea is advanced that the teratological structure just mentioned may be a new unit character of the genus *Calceolaria*. The statement is made that "no such character, so far as can be learned, is known in the Calceolarias, and it would seem to have been caused by the hybridization."

M. T. Masters[2] states that the formation of spurs or spur-like tubes is very frequent in some seasons in the corolla of certain Calceolarias (*C. floribunda*). An excellent figure (Fig. 169) is also given.

ORLAND E. WHITE
BUSSEY INSTITUTION,
HARVARD UNIVERSITY,
June 18, 1912

[1] SCIENCE, N. S., 35, p. 606, April 19, 1912.

[2] "Vegetable Teratology," 1869, p. 316.

SCIENTIFIC BOOKS

High School Education. Edited by CHARLES HUGHES JOHNSTON, Ph.D. Charles Scribner's Sons. 1912.

To designate this book a notable effort in pioneer-work is to indicate at once its merits and its inevitable limitations. In its arrangement, in the assignment of general and of specific topics to writers whose interests concentrate in their respective fields of inquiry, it proclaims the fundamental belief that no single writer can hope to do justice to all the issues involved in secondary education. Where questions of general policy, of programs of study, of curricula and of method in individual subjects must be weighed to promote the ideals of efficiency, it is desirable that the inquiring teacher shall have the guidance of a number of experts whose utterances will help him to plot his own line of procedure. It speaks well for the firmness of the editor that his collaborators represent almost without exception a uniform tendency, though they are permitted full leeway in the advocacy of their individuality. Professor Johnston has on the whole been fortunate in the choice of his cooperating writers; even for some of the subjects that have not yet found general recognition in our high schools he has secured contributors of distinctly originative ability. Even though this book may be superseded before long by similar studies of greater value, it may claim the merit of having led the way to a proper consideration of the manifold problems of the secondary school.

The discussion of the educational significance of the various subjects in the curriculum of a secondary school, and of the methods that will make their teaching most effective, is preceded by five chapters in which a basis for the whole question of secondary education is offered. Of these chapters easily the most notable is Professor Davis's on Principles and Plans for Reorganizing Secondary Education; in its outspoken criticism of our educational shortcomings and its helpful constructiveness, the utterances of this chapter should sink deep into the minds of teachers. With a wide perspective of the whole field, here and abroad, it abounds in proposals of betterment that are capable of realization, if our communities realize the value of broadly trained teachers. We should exceed the limits of this review if we were to quote from the wealth of sound doctrine, incorporated in this one striking chapter. Next to it in importance among the initial five chapters is that of Professor Elliott on the Organization and Control of Instruction; exception, however, must be taken to what seems an unfortunate separation of *supervisory* from *inspectorial* control. The two are inseparable; inspection should be a constant accompaniment of supervision, a measurement of the results growing out of expert direction. To assign these two functions to two sets of officers is to deprive supervision of its ultimate test of efficiency; it introduces the danger of mechanical measurement of results, of which the teachers in our large high-school systems could reveal many a distressing tale. Barring this one defect, the chapter is admirable; it protests against the peril of transitory enthusiasms, against encroachment of non-technical administrative boards on the free exercise of expert insight; it advocates a training of the teacher not according to academic standards, but according to standards erected for secondary education, and puts the responsibility for this mistake upon the colleges, where it properly belongs; it demands that the selection of teachers inhere as a prerogative in the supervising officer. It is significant too that, distinguishing *identity* from *equality* of instruction, Elliott urges as of special importance the differentiation of the content and method of instruction of boys from those of girls. Turning now to the twenty chapters that bear upon individual subjects of the curriculum, it is in no invidious spirit that single ones are selected for special commendation; those that contain besides fertile discussions of method in their own particular field, suggestions of procedure from which teachers of other subjects may readily profit. No teacher of true professional spirit but will appreciate Karpinski's article on Mathematics, Chase's on History, Kester's on Physics, and, above all, Denney's on English. In the latter chapter in particular there are massed so many practical devices to render the teaching of English more effective (pp. 234–38) that one regrets the absence of similarly helpful suggestions in some of the other chapters; culled from a varied and rich experience, from a study of every promising method that has borne fruit, these comments of a successful teacher surpass in value all generalizations of theory. Not merely what to undertake, but how to do it, is what our inadequately trained teachers (and they are, alas! in the majority) need to know.

In the article on physics the question of the value and relation of laboratory work as an element, but not the sole element, in the secondary teaching of the subject is discussed with much sanity, and there is emphasized an urgent plea for the consideration of the historical evolution of physical science, a phase of the work to which the French attach much significance, but which we have been apt to slight. It was well worth while to include in the series of chapters discussions of sex pedagogy in the high school and of psychology in the high-school curriculum, though in the former case the difficulty of rational handling of the subject is made prominent, and in the latter, doubt as to the advisability of its introduction is obviously felt by the writer. As to psychology, your reviewer has no hesitation in advocating its exclusion from the high-school curriculum; the immaturity of high-school pupils calls for an emasculation of the subject that renders it valueless.

No greater praise can be accorded to the publication as a whole than that it is an epochal contribution to the library of the high-sohool teacher.

Julius Sachs

A Monograph of the Mycetozoa: A descriptive catalogue of the species in the Herbarium of the British Museum. By Arthur Lister, F.R.S., F.L.S. Second edition, revised by Gulielma Lister, F.L.S. With two hundred and one plates and fifty-six wood cuts. London, printed by order of the Trustees of the British Museum. 1911. Octavo, 302 pp.

It marked an epoch in the study of these organisms when in 1894 Arthur Lister brought out an exhaustive monograph of the Mycetozoa based on the specimens in the British Museum. It was illustrated with seventy-eight plates of much more than usual merit, which proved invaluable aids to the student, as did also the illustrated keys to the genera which accompanied the "orders." Now, seventeen years later, and nearly four years after the author's death, a second edition is brought out by his daughter, who had aided him in the preparation of the first edition, as well as in the work undertaken in anticipation of the present edition. The result is a modernized and much augmented monograph, following, however, in the main the treatment given in the earlier volume. Some of the genera have been changed in their positions in the group, the most notable change of this kind being that by which *Lycogola* is moved from the Calonemineæ (with capillitium) to the Anemineæ (without true capillitium). In the new book families are still called "orders," in which one may discern the influence of the botanical nomenclature of the immediate English past. This appearance of botanical antiquity is shown also in the use of "Cohort" and "Sub-Cohort."

Comparing the two editions, one finds forty-nine genera in the new edition as against forty-three in the old, and two hundred and forty-six species in the new, to one hundred and seventy-six in the old. These numerical changes are mainly due to the very considerable increase of available material for study resulting from the widespread interest aroused by the publication of the first edition. Other changes which will be noted by the student of these organisms result in part from a better knowledge of their structure, and somewhat to the application of the laws of botanical nomenclature formulated in Vienna and Brussels, by which many names have been changed. For aid in this work cordial credit is given to Professor T. H. Macbride, the well-known American authority on the Mycetozoa.

Looking over the book, one is struck by the obvious mixing of botanical and zoological ideas. Nowhere in the book are the Mycetozoa spoken of as plants; nor on the contrary are they called animals. They are invariably called "organisms." Yet in the introductory chapter in connection with the statement that swarm-cells coalesce to form a plasmodium we are told that "in consequence of this discovery, which indicated a relationship with the lower forms of animal life, DeBary in 1858 introduced the name Mycetozoa." Yet the specimens on which the monograph is based are in the Herbarium of the British Museum, while the preface is written by A. B. Rendle, of the Department of Botany, and as has been said above the nomenclature has been revised in accordance with the laws of botanical nomenclature. Verily, it is difficult to break the traditions of even scientific men! If we were to take up the study of the Mycetozoa to-day for the first time it is certain that we should all agree that they are animals, but because they were thought to be plants for so long, it is difficult to transfer them from the plant kingdom to the animal.

And it must be confessed that the beauty of the spore-stage is so great that we can not blame the botanists for their unwillingness to let these pretty things escape from the botanical domain. There is also much the same feeling now among the myxomycologists that there was among the lichenologists thirty years ago when DeBarry and Schwendener and other botanical insurgents were saying that the lichens were fungi. And yet to-day the fungus nature of the lichens is conceded by botanists the world over. So it will be with the Slime Moulds, that are "passing," to be replaced by the Slime Animals.

CHARLES E. BESSEY
THE UNIVERSITY OF NEBRASKA

SCIENTIFIC JOURNALS AND ARTICLES

THE May number (Vol. 18, No. 8) of the *Bulletin of the American Mathematical Society* contains the following papers: "Definite integrals containing a parameter," by D. C. Gillespie; "On the V_3^3 with five binodes of the second species in S_4," by S. Lefschetz; "What is mathematics" (review of Whitehead and Russell's "Principia Mathematica"), by J. B. Shaw; Review of Bianchi-Lukat's "Differentialgeometrie," by L. P. Eisenhart; "Notes"; "New Publications."

The June number of the *Bulletin* contains: Report of the April meeting of the Chicago Section, by H. E. Slaught; Report of the twenty-first regular meeting of the San Francisco Section, by T. M. Putnam; "Implicit functions defined by equations with vanishing Jacobian," by G. R. Clements; Review of Darwin's Scientific Papers, by E. W. Brown; Review of Pareto's "Manuel d'Economie politique," by E. B. Wilson; "Notes"; "New Publications."

SPECIAL ARTICLES

THE LAWS OF PHOTOELECTRIC ACTION AND THE UNITARY THEORY OF LIGHT (LICHT-QUANTEN THEORIE)

IN a note which was published in a recent number of SCIENCE (Vol. 35, p. 783, May 17, 1912) Dr. Karl T. Compton and the writer announced, as the result of experiments, certain conclusions they had come to regarding the relation between the number and kinetic energy of the electrons emitted by different metals under the influence of light, on the one hand, and the frequency of the light and the position of the metals in the voltaic series, on the other. The following brief outline of a method of deducing and extending these laws from theoretical considerations, is not without interest.

Let N_v be the number of electrons emitted in unit time by unit area of a metal in the presence of unit density of isotropic radiation of frequency between v and $v+dv$, let T_m represent the maximum kinetic energy of these electrons and T_v their mean kinetic energy. The writer[1] has shown that N_v and T_m have to satisfy equations which can be reduced to

$$\int_0^\infty N_v h v^3 e^{-hv/R\theta}\,dv = A_1\theta^2 e^{-w_0/R\theta} \qquad (1)$$

and

$$\int_0^\infty N_v T_m h v^3 e^{-hv/R\theta}\,dv = 2A_1R\theta^3 e^{-w_0/R\theta}. \qquad (2)$$

In these equations h is Planck's radiation constant, A_1 is a constant characteristic of the material and independent of the temperature θ, w_0 is the internal latent heat of evaporation of one electron at the absolute zero and R is the gas constant reckoned for a single molecule. The following is a solution of equations (1) and (2):

$$N_v = 0, \text{ for } 0 < hv < w_0, \qquad (3)$$

$$N_v = \frac{A_1 h}{R^2 v^2}\left(1-\frac{w_0}{hv}\right), \text{ for } w_0 < hv < \infty, \qquad (4)$$

$$T_m = hv - w_0, \text{ for } w_0 < hv < \infty. \qquad (5)$$

Equations (1) and (2) have to be slightly modified when reflection of the electrons is taken into account. The result does not appear to make any important difference in (3) and (4) but, instead of (5), we get

$$T_v = s(hv - w_0), \text{ for } w_0 < hv < \infty, \qquad (6)$$

where s is the ratio between the proportion of the incident energy which is absorbed, and the proportion of the incident matter (or electricity) which is absorbed, from the stream of electrons which returns to the body in a state of thermal equilibrium. It can be shown that s lies between zero and unity.

If we define v_0 by the equation $w_0 = hv_0$ it can easily be shown that the experimental results announced by Dr. Compton and the writer are confirmatory of equations (3), (5) and (6). One of the most interesting consequences of the theory is equation (4) which has not yet been tested by experiment.

[1] *Phys. Rev.*, Vol. 34, February and May, 1912; *Phil. Mag.*, Vol. 23, p. 615, 1912.

There do not at present appear to be any considerations, either of theory or fact, which would limit the applicability of these laws to the comparatively narrow field to which the term photoelectric effect is usually restricted. For instance, there is no apparent reason why they should not be applicable to the ionization produced by such radiations as the Röntgen and γ rays. Moreover the deduction makes no essential use of the fact that the particles have been supposed to be electrically charged; so that similar laws may be expected to characterize the reversible formation of gaseous chemical products under the influence of ætherial radiations.

There is one other point. Equations (1)–(6) have been derived without making use of the hypothesis that free radiant energy exists in the form of "Licht-quanten," unless this hypothesis implicitly underlies the assumptions: (A) that Planck's radiation formula is true, (B) that, *ceteris paribus,* the number of electrons emitted is proportional to the intensity of monochromatic radiation. Planck[2] has recently shown that the unitary view of the structure of light is not necessary to account for (A) and it has not yet been shown to be necessary to account for (B). It appears therefore that the confirmation of equations (3), (5) and (6) by experiment does not necessarily involve the acceptance of the unitary theory of light.

O. W. Richardson
Palmer Physical Laboratory,
Princeton, N. J.

THE CAPE LOBSTER

In noticing the peculiar history of the animal from the Cape of Good Hope, designated under this head, I wish both to correct an error, and at the same time to direct attention to a little known individuality among the higher crustacea.

In a review of Dr. Calman's volume, "The Life of the Crustacea,"[1] this much abused animal was thus referred to:

We thought that this somewhat shadowy species had never recovered from the aspersions cast upon it by Professor Huxley.

Dr. Calman has kindly called my attention to the fact that the species is really a very substantial shadow, that its nebulous reputation disappeared some years ago, and that Huxley's remarks were not wholly justified in 1878, for the elder Milne Edwards had published a good figure of the animal as early as 1851. Indeed, as we shall see, his still earlier description was based upon an actual specimen.

In my first extended report upon the American lobster[2] the little Cape species was thus referred to:

A third form, *H. capensis,* has been imperfectly described from the Cape of Good Hope, but it is doubtful if it belongs in this genus.

Such doubt as then existed has since been cleared up, and the species should have been included in my recent work on "The Natural History of the American Lobster."[3]

The facts regarding the literary history of this neglected species are briefly as follows: It was first figured and described by Herbst under the name of "The Cape Crayfish," *Cancer* (*Astacus*) *capensis,* in 1796,[4] and in a way to puzzle all future students who placed any confidence in his statements. Under the head of "The Cape Crayfish" was this brief description: "Museum Spengler. *Astacus,* slender, with smooth thorax; claws (manus), hairy, with crenate border; all the legs chelate"; followed by this even more vague and contradictory account:

This beautiful crab (Krebs) occurs at the Cape in mountain streams. It is similar indeed to our common crayfish, but is more slender, and of equal

[1] See Science, N. S., Vol. XXXV., No. 892, February 2, 1912.

[2] *Ber. der. Deutsch. Physik. Ges.,* 1912.

[2] "The American Lobster: A Study of its Habits and Development," Bulletin of U. S. Fish Commission for 1895, p. 8.

[3] Bulletin of the Bureau of Fisheries, Vol. XXIX., Document No. 747, issued July 13, 1911.

[4] Johann Friedrich Wilhelm Herbst, "Versuch einer Naturgeschichte der Krabben u. Krebse, nebst einer systematischen Beschreibung Arten. B. 2, Krebse," Tab. XXVI., Fig. 1, and p. 49. Berlin u. Stralsund, 1796.

breadth throughout. It is coral red in color and has a beautiful sheen resembling the carnelian. Whether this is its natural color, or whether it is due to cooking, I can not decide. The appendages are relatively small. The base of the hand (carpus or fifth segment) nearly surpasses the arm (meros or fourth segment), and is strongly tuberculated; the hands are large, and are bordered, moreover, with a very delicately raised and toothed margin (Rande), studded everywhere with yellowish, transparent hairs. The feet are all chelate, while in the common crayfish the first pair only have this character.

This faulty description seems to have been drawn from an imperfect specimen, or with insufficient care, supplemented by incorrect data in regard to habit, and not very happy guesses in filling up the gaps of whatever sort.

Herbst's work was in a large measure a compilation, being at the same time a curious and interesting epitome of the life and lore of the Crustacea from the most ancient times. The numerous drawings which were in copperplate and colored by hand, are rather poor even for the period (particularly in this volume), when not copied from a master, like Roesel von Rosenhof. Any statements regarding the problematical Cape species need not have been taken too seriously, when of the common European lobster which had been known and eaten from antiquity, he stated in the same paragraph, that it carried its eggs under its tail, and laid them in the sand.[5]

As an illustration of another side of Herbst's work I give the following in free translation:

Crayfish, when kept in confinement are fed with beer daily, or with sweet milk, which is better, and of which they are very fond.

It is in this work also that we have a figure of the Pope's head in the lobster's stomach (Tab. 46, fig. 5), for as the writer says:

The middle and lateral teeth (of the gastric mill) give a striking impression, and may be likened to the Pope, seated in the choir with his cardinals (p. 205).

If the legs of Herbst's "Krebs" were all chelate, or if it lived in mountain streams, as Professor Huxley remarked,[6] it could be neither crayfish nor lobster, since in both there are but three pairs of chelate or double claw-bearing legs, and the lobsters were, so far as known, exclusively marine. On the other hand Milne Edwards at an early period rightly showed that Herbst's *Cancer* was a true lobster, and as such briefly described it in his "Natural History,"[7] under the name *Homarus capensis*. His description, now known to be correct, so far as it goes, was as follows:

Body slender; rostrum flattened, much shorter than the peduncles of outer antennæ, and finely toothed along its borders. Carpus granular; hands elongate, greatly compressed, garnished over their upper surface with a finely denticulate crest, and covered with hairs above. Length about 5 inches.

That this description was made from an actual specimen we have the testimony of Milne Edwards himself, who, as Stebbing remarks, placed after it in his "Natural History," the letters "*C. M.*," which mean "those species which exist in the Museum of Natural History, where they will be found arranged in the same order as in this work." The drawing of the species, which as we have seen was published fifteen years later, excepting the crude figure of Herbst, remains the only one in existence to this day. Unfortunately Milne Edwards's figure appeared in a highly technical paper of a general character,[8] where it

[5] "The pairing season (of the European lobster) begins in spring, and continues during most of the summer. Their fertility is uncommonly great; *12,444 eggs have been counted under the tail of a single lobster,* not to speak of those which still remained in the body. *They lay their eggs in the sand, where they are hatched by the sun.*" Italics mark this contradiction, which is the more singular from the fact that Roesel's figure of the crayfish's eggs attached to the swimmeret is reproduced. The last statement was probably copied from Pennant.

[6] Huxley, T. H., "On the Classification and Distribution of the Crayfishes," *Proceedings of the Zoological Society of London*, pp. 752–788, London, 1878.

[7] "Histoire naturelle des Crustacés," T. 2, p. 335, Paris, 1837.

[8] "Observations sur le Squelette Tégumentaire des Crustacés Décapodes et sur la Morphologie de ces Animaux." Plate 11, fig. 1, *Ann. Sci. Nat. Zoologie*, Sér. 3, Vol. XV., Paris, 1851.

was inevitably overlooked, since this species was used merely as the exponent of the genus, and is referred to but once by name, and that under the description of the plate.[9] Huxley was no doubt familiar with this paper, but had he recognized the drawing, he would have certainly referred to it, and the "hopeless perplexity," to which he confessed "respecting the Crayfish or Lobster which is said to occur at the Cape of Good Hope, *Cancer* (*Astacus*) *capensis* of Herbst," would have been mitigated if not removed.

It is evident from the preceding account that the Cape of Good Hope lobster enjoyed a vague and uncertain literary reputation up to 1902 when it was redescribed by Stebbing[10] who gave the first full and accurate description of this interesting form from specimens furnished by Dr. Gilchrist.

The two specimens, a male and female, described by Stebbings, agree closely with the description of Milne Edwards. The serrated rostrum has no teeth on the lower side, and its apex extends beyond the base of the third segment of the first antenna.

A very interesting fact, but still commonly overlooked, is the periodic arrangement, in series of eight, of the spines of the toothed forceps of the European and American lobsters. Though less striking, the arrangement of the tubercles of the cracker claw is characteristic. So far as can be judged from Stebbings's description, these peculiarities are less marked or altogether wanting in the Cape lobster. Of the larger forceps he says:

> The marginal teeth are few and not bulky, hairs at the base of the thumb partly filling the cavity between it and the finger.

In the smaller claw there are said to be "many minute but unequal teeth, and a long brush of hairs."

In the American lobster the rostrum is serrate with fewer and larger teeth; there is usually a spine on its under side near the apex, which extends considerably beyond the third segment of the first antenna. In specimens from three to four inches long short hairs partially fill the cavity between finger and thumb of the larger claw, while the serial teeth of the toothed forceps are quite concealed by matted tufts of setæ, like round stub-brushes, set in rows. The outer margin of the thumb (propodus) carries at its tip a row of about 14 such brushes, made up often of a hundred or more sensory hairs. Moreover, the "lock" or toothed forceps has a locking device, by means of which the jaws when closed can not be moved laterally or strained either up or down; this is effected by a displaced "lock" spine, overlapping tips, and a reversal in the alignment of the teeth whereby they overlap, and do not interlock.[11] A corresponding reversal is seen in the alignment of the setæ, the denser row being uppermost in the thumb (propodus), and lowermost in the dactyl.

To conclude this account of the Cape lobster I quote from Stebbings:

> The color (so far as known), the small size, the pubescence of the body and claws, and the flattened hands of the front chelipeds, will sufficiently distinguish this neat little South African species, less than four inches long and less than three quarters of an inch broad, from the clumsier lobsters of the north.

At last the Cape lobster thus emerges as a true species, of small size and attractive appearance, and like its more famous relatives in Europe and America, it lives only in salt water. It is sincerely hoped that zoologists will not have to wait another half century for an adequate account of both its habits and development.

As if this form were doomed to confusion, Stebbings persists in using the term *Astacus* for the lobsters, but since the decision of the

[9] Singularly enough in my copy of this paper the last page bearing the name of the lobster is missing, though the description has been supplied in manuscript.

[10] "Marine Investigations in South Africa," Vol. 1, p. 34, Cape Town, 1902. See also Stebbing's "General Catalogue of South African Crustacea," *Annals of the South African Museum*, Vol. VI., p. 378, London, 1910; also Calman's review of the same, in *Nature*, Vol. 86, p. 174, April 6, 1911.

[11] See "Natural History of the American Lobster," p. 261.

International Commission on Nomenclature was rendered in August, 1910, in favor of restricting *Astacus* for the crayfishes and *Homarus* for the lobsters, it is hoped that this needless source of misunderstanding will be eventually removed.

FRANCIS H. HERRICK
WESTERN RESERVE UNIVERSITY

A PANUM INCUBATOR WITH IMPORTANT MODIFICATIONS

ONE of the most pressing needs of a general bacteriological laboratory is an incubator which possesses compartments of different but constant temperatures. Various types have been constructed and are in use to-day. After a rather extended investigation into the subject of incubators the writer chose the so-called "Panum" model with certain modifications. An admirable description of this incubator, together with certain improvements which it has undergone in the Carlsberg laboratory, is given in Klöcker's "Fermentation Organisms."[1] A brief description seems desirable here, in order to impress upon those who are not familiar with the apparatus its salient characteristics.

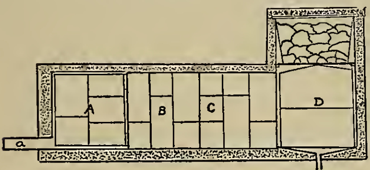


Fig. 1

The incubator consists of three main parts (Fig. 1, *A*, *B–C*, and *D*) which are constructed separately, preferably of thick sheet metal. These three parts are soldered together. The first compartment, *A*, is double-walled. The space between the two walls is filled with water, which is kept at the required temperature by a safety gas lamp which is controlled by a thermo-regulator (*b*). The gas lamp is placed under a projecting wing (*a*) of the outer metal wall. As this wing may burn through in the course of time it is connected with the water jacket by means of screws and flanges which are provided with rubber packing. The projecting wing may be replaced when necessary, without any difficulty. The space between the two walls of *A* is filled with water poured in through holes in the top. The water may be run off through a stopcock situated on the wing.

Compartment *A* is divided into halves by a vertical partition. Division *B–C* is divided into two compartments each of which is subdivided into three equal sections by vertical metal partitions. All of the divisions are provided with two shelves which may be placed at any desired height. The last main compartment, *D*, serves as a refrigerator. It possesses an inner receptacle, the roof of which slopes to the sides and back. This inner box is cooled by water which trickles down over it from ice which is held on a strong grating. The water is run off through an opening in the floor of the main compartment. The ice container is covered with a metal lid over which a thick wooden lid is made to fit closely.

The entire apparatus, with the exception of the front, is covered by a layer of felt 8 centimeters thick and enclosed in a wooden box.

In the words of the book, "Each of the spaces 1 to 8 is provided with a tightly fitting glass door, and doors of sheet iron are fitted on each of the four large compartments, *A*, *B*, *C* and *D*, which are closed tightly by pressing against rubber strips fitted on the partitions. Four corresponding doors, also fitting tightly, are attached to the wooden case, their inner sides being coated with woolen pads. All these doors are hinged below, and when opened and resting in a horizontal position on adjustable brackets may be used as tables."

In the particular incubator under consideration it seemed desirable to make a number of changes or improvements over the model just described. In the first place, heavy copper sheeting was used throughout the apparatus, with the view, of course, of making all the parts more permanent. Besides soldering the three separate divisions

[1] Published by Longmans, Green & Co., London and New York.

together, they were fastened together with bolts or rivets. This makes it impossible for the parts to draw apart and thus greatly reduce the efficiency of the entire incubator.

The greatest departure from the original was made in the construction of the doors. The large doors opening out on hinges at the bottom seemed highly objectionable from the standpoint of convenience for those who regularly make use of the apparatus. Instead of providing each of the four main compartments with two single doors, one set of double doors was fitted to each division. These doors are made of heavy copper sheeting, and are two-walled. They are about three inches thick, and are so constructed as to fit perfectly into the fronts of the respective compartments, and to come together in such a way as to allow of no appreciable diffusion of heat. They swing on hinges at the sides of the divisions. The hinges are firmly attached by a special device. The doors are made to close tightly by means of fasteners situated at the tops and bottoms. Besides the single pair of doors for each large division, each small compartment is provided with its own movable glass door, as in the original model. The two-walled thick outer door, which is filled with air space, makes a third door unnecessary.

The approximate dimensions of the incubator are as follows: Length (outside measurement), 8 feet and 9 inches; height (not including ice box), 2 feet and 9 inches; width, 2 feet and 6 inches. Inside measurements of individual compartments: Divisions in section *A*, each 11 inches wide and 23 inches high; separate compartments in sections *B* and *C*, 8 inches wide and 23 inches high; and the inner receptacle or box in the refrigerator division, 23 inches cube.

The incubator rests on a strong wooden stand which is 30 inches high. At the refrigerator end there is a specially constructed platform by means of which the ice carrier has easy access to the ice box. To further facilitate the replenishing of the ice supply, the outer lid of the ice box has attached to it a stout cord, to the further end of which a heavy iron weight is fastened. The cord passes over a pulley which is fixed to the ceiling of the room.

The apparatus has been in operation for almost a year, and has proved highly satisfactory. The temperatures in the different compartments have been practically constant, even when there were marked fluctuations in the temperature of the room. To obtain the maximum efficiency, however, the thermoregulator must be in good working condition, and the ice supply must be replenished at regular intervals. The incubator has been in operation during the warmest summer season as well as in the coldest winter months, with but very slight variations in the inner temperatures, except during a few days of last summer when the temperature of the room was far above blood heat.

Aside from tests made by myself frequently, a rather exhaustive investigation of the constancy of the temperature of the different compartments was made by certain members of the Yale biological department in connection with their determination of the temperature coefficient of the rate of reproduction of *Paramecium aurelia*.[2] The temperature in each compartment was recorded by a tube thermometer, a maximum and minimum registering thermometer, and in one chamber also by a thermograph. In their report of the investigation we find the following statements.

> The temperatures of the various compartments were not only kept practically constant, but, which is more important from the standpoint of these experiments, the very slight variations which occurred, appeared practically the same in all the compartments simultaneously.

Leo F. Rettger

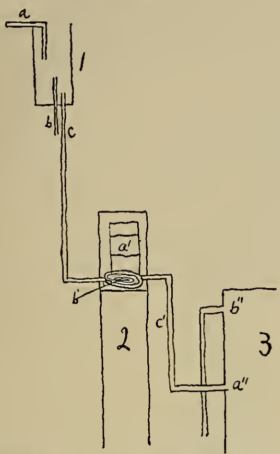
Yale University

A CONVENIENT 20° INCUBATOR

An incubator that will work satisfactorily with gelatin culture media during the hot summer and in our usually superheated laboratories in winter is a great desideratum. A number of expensive devices of this character

[2] Woodruff and Baitsell, *American Journal of Physiology*, XXIX., 147–155, 1911.

are on the market. The apparatus here described may be set up by any plumber at a very small expense—possession of refrigerator and incubator assumed.



(1) Small tank for constant head, about 1 ft. in each dimension. *a*, inflow; *b*, overflow; *c*, lead pipe. (2) Refrigerator. *a'*, ice; *b'*, flat coil under ice; *c'*, outflow to incubator. (3) Incubator. *a''*, cold water inflow; *b''*, overflow; thermometer and burner omitted.

The diagram explains the construction. The constant-head tank is placed 3–4 feet above the refrigerator. I have used ⅜ in. lead pipe with twelve turns under the ice (slightly larger would be better). With rather soft artificial ice the water flowing into the incubator has a temperature of about 14° C. The incubator temperature desired is, of course, determined by the thermo-regulator. I have been using a small Reichert regulator and natural gas. Under these rather unfavorable conditions I find a range of about 1° C. around 20° C. The results obtained in growing cultures have been entirely satisfactory during the past four years.

Chas. B. Morrey
Ohio State University

THE AMERICAN ASSOCIATION OF MUSEUMS

The American Association of Museums held its seventh annual meeting in New York City from June 4 to 7. There was a large number of members in attendance and the convention may be considered in every way a success. Sessions were held at the American Museum of Natural History, the Metropolitan Museum of Art and the Museum of the Brooklyn Institute of Arts and Sciences. Addresses of welcome were made by Dr. Henry Fairfield Osborn, president of the American Museum of Natural History; Mr. Robert W. de Forest, secretary of the Metropolitan Museum of Art, and Mr. Edward L. Morris, acting curator-in-chief of the Museum of the Brooklyn Institute of Arts and Sciences, and the following papers were read:

"Notes on Russian Natural History Museums," by A. R. Crook.

"An Adaptation of the Goodyear Classification of the Fine Arts to the Dewey System of Numbering," by Laura M. Bragg.

"The Lasting Qualities of a Mounted Mammal Skin," by Robert H. Rockwell.

"The Preparation of Ecological Invertebrate Groups," by Roy W. Miner.

"Wild Life of the Far East," illustrated by motion pictures, by Cherry Kearton.

"The Value of Photographs and Transparencies as Adjuncts to Museum Exhibits," by Caroline L. Ransom.

"The Care and Classification of Photographs at the Metropolitan Museum of Art," by Ethel Pennell.

"The Function of a Museum," by Paul M. Rea.

"The Training of Museum Trustees," by Charles Louis Pollard.

"Boards of Trustees and the Executive Officers of Museums," by Henry L. Ward.

"Why is a Museum," by Chester L. Boone.

"Laboratory and Museum Shelving," by Milton J. Greenman.

"Conveniences in Installation," by C. F. Millspaugh.

"Glossary of Art Terms," by Henry W. Kent.

"The Local Flora Problem of a Small Museum," by Eva W. Magoon.

"The Possibilities of Botanical Exhibits," by E. L. Morris.

"The Duty of American Zoologists to Wild Life," by William T. Hornaday.

"Method of Exhibiting Insect Collections," by Frank C. Baker.

"Non-evaporating Mounts for Alcoholic Specimens," by Roy C. Miner.

"Some Experiments of a Small Museum," by Harold Madison.

"Lantern Slides in Geography Work," by Carlos E. Cummings.

"Circulation Cases for Mounted Birds," by Herbert E. Sargent.

The Round Table discussions included five topics, "The Insurance of Museum Collections," "The Classification of Specimens," "The Possibilities of Systematic Cooperation between Large and Small Museums," "An Exhibition to Show the Destruction of Wild Life and the Extermination of Species" and "The Handling of Classes in Exhibition Rooms."

A day was spent by the association at the Bronx, visiting both the Zoological Park and the Botanical Garden, and trips were made to the Museum for the Arts of Decoration at Cooper Union, the New York Aquarium, and the Children's Museum of the Brooklyn Institute. Many remained over Saturday in order to accept the invitation of the Staten Island Association of Arts and Sciences to inspect its museum and to see the island.

In executive session the council voted that it should be the policy of the association to deal with the principles of organization and administration of museums and with their problems of technique rather than with matters of art, history or science as such.

Balloting for officers for the year 1912–13 resulted in the election of Henry L. Ward, Public Museum of Milwaukee, for president; Benjamin Ives Gilman, Museum of Fine Arts, Boston, for first vice-president; Oliver C. Farrington, Field Museum, Chicago, second vice-president, and Professor G. S. Morse, Peabody Museum, Salem, and Professor William C. Mills, Ohio State Archeological and Historical Society, Columbus, Ohio, as councillors for the next three years. The secretary, Paul M. Rea, Charleston Museum; assistant secretary, Laura L. Weeks, Charleston Museum; and treasurer, Dr. W. P. Wilson, Philadelphia Museums, were reelected. The four councillors continuing in office are Frederic A. Lucas, Henry R. Howland, Frederick J. V. Skiff and Henry W. Kent.

The association will meet next year in Philadelphia.

Paul M. Rea,
Secretary

SOCIETIES AND ACADEMIES

TORREY BOTANICAL CLUB

The meeting of March 12, 1912, was held at the American Museum of Natural History at 8:15 P.M. The meeting was called to order by Dr. Z. S. Leonard in the absence of officers of the club. Mr. Sereno Stetson was appointed secretary pro tem. Twenty-five persons were present.

The paper of the evening consisted of an illustrated lecture by Dr. Marshall A. Howe on "Some Floral and Scenic Features of Cuba." Lantern-slide photographs were shown illustrating characteristic Cuban plant associations, particularly in the provinces of Oriente, Camagüey, Matangas and Pinar del Rio. Special attention was given to the numerous native palms of the island and to the cacti of the Guantanamo Bay region. The sugar, tobacco and fruit-growing industries of Cuba were also illustrated and commented upon.

Sereno Stetson,
Secretary pro tem.

The meeting of March 27, 1912, was held in the lecture room of the New York Botanical Garden at 3 P.M. Vice-president Barnhart presided. Forty persons were present.

The scientific program consisted of a lecture on "Organization of *Pediastrum* Colony," by Professor R. A. Harper. The lecture was illustrated with lantern slides.

The meeting of April 24, 1912, was held in the Laboratory of the New York Botanical Garden at 3:15 P.M., Dr. W. A. Murrill presiding. Fifteen persons were present.

The scientific program consisted of a paper on "Plant Hairs," by Dr. William Mansfield. The speaker exhibited a number of figures representing various types of plant hairs and showed how the four main types, simple, compound, septate and non-septate, could be made the basis of a key by which many species of plants could be identified.

The meeting of May 14, 1912, was held in the American Museum of Natural History at 8:15 P.M. President Burgess presided. Nine persons were present.

The scientific program consisted of an illustrated lecture on "Dr. Charles H. Shaw's Botanical Studies in the Selkirks," by Miss Caroline S. Romer.

B. O. Dodge,
Secretary

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RESEARCH FOUNDATIONS IN THEIR RELATION TO MEDICINE[1]

At this time and place, medicine is the central interest, and therefore, so far as a layman can, it is my purpose to discuss "Research Foundations in their Relation to Medicine," and if possible to do this in such a manner as to reveal their significance to those for whose encouragement these ceremonies have been devised.

To accomplish this I intend first to ask you to consider the mental attitude necessary for the appreciation of research foundations and then to describe these foundations broadly—trying to indicate their relations to the universities; the problems which arise in connection with them; the dangers to which they are exposed; and their significance for the progress of medicine, for yourselves and for the development of the spirit of research.

You who are about to pass from the discipline of the school to a more self-dependent phase of your career feel both the fresh pleasure of restraints outgrown and a questing interest in the coming years. You feel too that, broadly speaking, what will happen to medicine during the next fifty years will also happen to you, and that at any moment some of you may be called upon to guide these happenings.

In the face of such responsibilities it becomes a duty as well as a wise precaution, to obtain the broadest possible view across your chosen field and to gain knowledge of the larger changes and improvements taking place within it.

You may have done this several times

[1]Address at the graduation exercises of the Yale Medical School, June 17, 1912.

before, but I venture to predict that if you live and succeed, you will do it many times again.

The Greek philosopher Heraclitus laid weight on the idea that all things are in a state of flux. The notion has not always been approved. We know that this idea in some of its aspects was repugnant to the early Victorian gentlemen, but to-day we are less prone than those of earlier generations to dogmatize on the impossible, and in this country and this phase of civilization, we feel with its full force the forward flow of things, so that for us nothing is more certain than the progressive change and onward movement in medical theory and hence in medical practise.

During the years of your training you have been carried more or less unconsciously along and thus helped to keep in touch with the development of medical thought, but at this moment, when the stream of knowledge is about to cast you out upon its shores and you are asked to walk on alone, it is worth while to inquire what is your preparation for the experience.

From these halls and laboratories you bear away a load of learning—haply you bear it lightly. It is to this possession that I wish to direct attention for a moment.

The knowledge we accumulate is a very mixed article, but in this mixture there are two sorts which it is well for us to consider now. One sort consists of certain formulas which control our incidental actions; for instance, we all know on occasion when to stand up or to sit down, and you know the technique and procedure for various surgical operations. A great fraction of our information is in this form, a form not necessarily subject to frequent or radical change. This sort, however, is of minor interest to us now, and has been mentioned here only that it may serve as a foil to the more important kind.

This more important kind of knowledge is that on the basis of which we can foresee and predict.

There are manifold varieties of this and they range from that which permits us to predict with a high degree of confidence the rising of to-morrow's sun, to that with which one ventures to predict the weather or the fate of a patient with baffling symptoms.

In these latter instances the course of events is by no means unpredictable, but only so dependent on complex factors and conditions that we rarely have at once at hand enough information to make a respectable guess. This fact bears very directly on the matter before us, for when we scrutinize our intellectual possessions we find them to consist in large measure of information useful for prediction, yet mainly information so incomplete that the conclusions or theories—if you choose—based on it must be largely held as open to revision and therefore can be used with safety only by those who carry in mind just how much or how little each conclusion has to rest upon. Nevertheless, it is just these tentative conclusions or theories which the medical man must so largely utilize. Probably you have thought of this before; if so, you know that to the revelations of this analysis men react in very different ways. Some throw up their hands in the face of so much uncertainty; others stretch certainty to the limit and seek to make it cover all they have been taught and then cultivate impenetrability because change is disquieting and new knowledge means new labor, while those born under happier stars are neither crushed nor blinded, but recognize that intellectual health and vigor imply an unceasing replacement of both data and conclusions, to be accomplished only when the period of mental growth is made conterminous with life.

Capacity for such continued growth is conspicuous in the masters and a hall mark of the eminent. Indeed, as you proceed in the investigation of your fellows, you will be surprised to find how early growth may cease and how significant the event can be. In far-distant communities mental growth has been known to stop on commencement day. It is consoling, however, to be assured—as I can assure you—that we observe this woeful arrest more clearly and sooner in our fellows than in ourselves—a suggestive fact which needs only to be mentioned in order to be appreciated.

As you see, the reason for this preface touching the nature of our mental possessions is my wish to emphasize the need for the full recognition of the unsolved or partly solved problems in medicine and the necessity for holding in mind the facts on which all such tentative solutions as we use are based. When this need has been recognized, it is possible to take the point of view from which research foundations can be discussed with greatest benefit, for primarily it is their purpose to replace less certain by more certain facts. Indeed, discussion of these foundations can be significant only for those who, like yourselves, know that the students' career is for life, never to be commuted—not even for good behavior—and in no wise limited by any formal function, such as graduation or a state board test.

Turning now to the research foundations themselves, it may be well, by way of introduction, to give a word of explanation touching the coming treatment of them. I desire to speak as an inquirer, not as an advocate, but as these inquiries have led me to some definite conclusions, I shall venture to express them briefly. Beyond this, all things rest with you.

While we are specially interested in research foundations in their relation to medicine, yet those with such relations are but a fraction of the number in existence and for the most part have come late.

A research foundation may be defined as one especially intended to produce new and better knowledge. Thus the main purpose and aim serves broadly to differentiate such a foundation from the universities and other educational establishments in which a greater emphasis is put on the conservation, distribution or application of knowledge, while at the same time both sorts of institutions have been and are producers also. The new foundations are then by no means essentially novel, but in one sense outgrowths or specialized extensions of the older educational establishments. This implies of course that what they are devised to do has already been included in the existing scheme of things.

Such being the case, our discussion must be framed so as to comprise these facts.

In the civilization from which we are descended there has always been some endeavor to add to the sum of human knowledge.

The acute minds belonging to the end of the medieval period often overstepped the theological and philosophical bounds within which they had their greatest activity, and gave to the study of the physical world more or less attention. Speculating, compiling, teaching and even experimenting, these men grouped here and there formed the centers from which the earliest universities of our era sprang.

Later appeared the learned academies, also sometimes the patrons of investigation. As objects of study, the physical problems came first, aided by the fact that observational and experimental work could be there begun without the preliminary labors of collection and classification which have necessarily occupied so much time in the biological sciences.

What is important to point out here is this: That whether we date the founding of the modern university laboratory from Lomonossoff at St. Petersburg in 1748, or from Liebig at Giessen in 1826, we must admit that a good deal of investigation had gone on in all the principal departments of science previous to such foundations, and thus in earlier times investigations were made in scientific workshops unconnected with teaching institutions. This fact suggests that perhaps our research foundations have even less novelty than we were at first inclined to accord to them, and that we are dealing now rather with a reappearance of conditions—much improved, to be sure—but quite familiar before the rise of our modern universities. It has a direct bearing on this point to note that in England, for example, during the earlier part of the last century when the historic universities of that country gave only meager support to experimental science and especially to the biological investigations, much of the most important work was done outside of the teaching institutions.

Joule, the student of the mechanical equivalent of heat; Perkin, discoverer of the aniline dyes; Bentham and the Hookers, all three botanists; Galton, the anthropologist, and Darwin, are some instances.

Moreover, for more than a century the Royal Institution of Great Britain, the foundation of which in 1799 was largely instigated by our fellow countryman, Count Rumford, furnished opportunities for research to Davy, Faraday, Tyndall and Dewar, all men whose contributions to knowledge have been of great importance.

According to its charter, the Royal Institution was "an establishment in London for diffusing the knowledge of useful mechanical improvements" and "to teach the application of science to the useful purposes of life."

This does not sound like the program of a research institution to-day. I can not say just what the steps were which led in this case to a development seemingly so different from that proposed, but it is not rash to assume that the men like those who have been named were always hunting reasons and explanations, knowing quite well that others could carry out the application, while it was theirs to make the fundamental discoveries; an excellent example of the well-known fact that where an institution and a strong man are left to work out the problem of adaptation, it is the institution that gets adapted.

Returning from this diversion to our history, and taking the period from the middle of the preceding century to the present day, one can not fail to recall in this country such an example as the Smithsonian Institution at Washington, and I would add our agricultural experiment stations which started right, then faltered, but are now coming into their own.

More extensive in scope and with far greater resources than any of these is the Carnegie Institution of Washington, whose magnificent undertakings in the field of science are well known, representing as they do a long series of research stations.

The ideas behind these several foundations are of the greatest interest. In his program of organization, in 1847 Joseph Henry, first secretary of the Smithsonian Institution, states the following:

> To increase knowledge: it is proposed (1) to stimulate men of talent to make original researches by offering suitable rewards for memoirs containing new truths and (2) to appropriate annually a portion of the income for particular researches under the direction of suitable persons.

This is what one might expect from Joseph Henry.

Touching the agricultural experiment stations, the history is complicated and perplexing, but we are justified, I believe, in carrying back the guiding idea in their development to that expressed by Washington in his annual message to Congress in 1796, where he says, when pleading for the establishment of a national board of agriculture, that one of the functions of such a board should be "to encourage and assist a spirit of discovery and improvement . . . by stimulating to enterprise and experiment." This is certainly sound doctrine.

The Carnegie Institution in the original formulation of its general plans was much influenced by the experience and early program of the Smithsonian Institution, but the original statement of aims strikes a new note when it declares one of these aims to be

> To discover the exceptional man in every department of study whenever and wherever found, inside or outside of schools, and enable him by financial aid to make the work for which he seems specially designed, his life work.

It is said that this paragraph touching the exceptional man has caused much trouble to the Carnegie Institution and often spread its path with thorns. It appears that in some instances it has been misunderstood. Self-discovered exceptional men have proved to be embarrassingly numerous. That does not strike one as so very strange, however, since the community grows wise but slowly.

The word "exceptional" you see has suffered misinterpretation. The really exceptional man is not so often the aberrant prodigy as the individual who presents in his composition a large collection of first-rate qualities, no one of which is necessarily alarming, but all of which together make for scientific effectiveness of the highest order. In the course of its development, the Carnegie Institution has, I think, lived up to this ideal with notable success—putting the saner interpretation on the word "exceptional." My commendation of the paragraph is similarly based.

But none of these instances which I have mentioned—together with a large group of others—come very close to medicine. This contact was first clearly established in 1888 by the Pasteur Institute in Paris, an institute intended to facilitate the work of the great scientist whose name it bore, and to continue the remembrance of him. It was an instance of the generous giving of aid and assistance to a master-man—with no prescriptions and no hampering limitations. Pasteur was a genius who combined the art of mediation between the laboratory facts and practical problems, with the capacity for speculative thought and scientific achievement in the highest sense, and who, nevertheless, did not allow his human interest to impair his scientific thoroughness.

In this country among the foundations closely related to medicine we have recently seen established the Rockefeller Institute, the Memorial Institute for Infectious Diseases, the Ortho S. A. Sprague Memorial Institute, both of these at Chicago, together with a number of others representing much the same purpose, but with less ample resources, as well as several funds devoted to the study of cancer, tuberculosis or other special diseases. These instances, because they touch medicine, might well be examined in detail, but we shall discuss them only in their most general relations.

It seems a fair question to ask why these institutes and funds have been established. The immediate causes are plain enough, and are frankly philanthropic in most cases. Personal experience with a disease has led more than one man to devote a large sum to the search for its control or cure or going a step further, and recognizing that the application of laboratory results to medicine has brought progress, some have desired to furnish opportunities by which this application may be accomplished where it seemed most needed. Though not always explicitly expressed, the programs of these foundations imply the hope that by such endowments new facts and new points of view fundamentally important to medicine may be discovered.

I like to think that this last idea is at least latent in all these endeavors, but nowhere, so far as I know, is quite the same note struck as that which is sounded in the initial program of the Carnegie Institution in those words which call attention to the exceptional man—the investigator.

Turning now to some of the relations involved, it is to be observed that these new foundations are independent and not connected with existing universities, that they tend to draw men from university positions by the attraction of unusual opportunities for work, and finally, that for the most part they take these men away from formal teaching.

The situation thus created in the world of education has often been lamented and no little moral pressure is exerted from time to time to induce the institutes to see the wrongness of their position.

The question thus raised amounts to this: Are these new foundations philanthropic vagaries and mere torsos of educational establishments, or do they represent the result of mature consideration and a definite endeavor to advance?

Of the several reasons which have brought about the independence of these foundations the common desire to keep alive the donor's name and fame has played its part, but more than this I think has been the feeling that since these foundations were to be devoted to research, either in the line of mediation to which I have already referred, or in the endeavor to obtain new truths of fundamental importance, therefore the workers in these institutes should be as far as possible released from any duties likely to divert their energies. To make this arrangement within the limits of a university is, to say the least, to subject the favored appointee to no little strain.

His colleagues, being human, at heart often resent his seeming freedom from responsibility and he is allowed to feel that somehow he does not justify himself by attending to his work alone. It is unnecessary to enlarge on this situation, but I can assure you that it is no mere product of my fancy. Separateness of management brings protection therefore to those who choose this work.

Still more important for ultimate success is the general conduct of such a foundation. Our universities are guided by experienced administrators who feel keenly the need for the diffusion of knowledge, for making it accessible to large numbers and for preserving withal a completeness and balance in their institutions.

These views become ingrained, but they do not represent the aims of a research foundation and the same board could hardly manage both with like success. For the investigator, buildings are fine when they suit his purpose; after that he loses interest. His notion of efficiency is a large emergency fund and whether the fixed charges are great or small is not so important as the means to act promptly, decisively and even expensively when occasions arise. This arrangement is possible only when the institution is a good deal of a unit and absolutely free.

To appreciate the needs thus briefly outlined requires the experience which breeds sympathy, and it has thus come to pass that so far as the arrangement of the scientific program, the formation of the personnel and the expenditure of funds are concerned, the control in many of our institutes is in the hands of the staff, aided by a small group of scientific advisers, themselves active workers and keenly alive to the needs of the investigator. This leaves the actual care of the funds with the trustees, but puts the scientific activities in the hands of scientific men. The arrangement solves several problems and seems essential for the healthy development of research foundations.

In view of all of these facts it does not appear very strange that independence has been desired for the newer establishments.

This brings us to the problem of getting men—men who will attempt to realize the highest aims and aspirations of these foundations. These have been taken largely from university laboratories and have been attracted to the newer work by the prospect of more time and resources to apply to their chosen problems and by more fitting salaries.

Of course it has happened at times that in arranging the program of some foundations, emphasis has been put on finding the answer to some specific question which was in the donor's mind. This is unfortunate so far as it implies a limitation of the scientific work, but on the other hand, in many cases the investigator has been given ample freedom to pursue his own course and devote his time to matters often seemingly remote; in other words, to follow where his research led. The situation demands above all things faith in the sincerity of purpose of the investigator, and fortunately this is granted with increasing frequency.

In these institutions which serve to mediate, on the one hand, between the findings of science and practical problems, and on the other to give opportunity for the attainment of fundamental facts, there is a constant danger threatening every searcher after new knowledge. The mediation work, because it involves as one element a practical problem, is moderately intelligible to the laity and extremely handy when it comes to giving an account of things done. It may become thereby unduly attractive.

By contrast, the search for the new knowledge is rarely intelligible to the community at large, and must often be described in terms of things in mind rather than of things accomplished, and thus this kind of activity often lacks for encouragement. Let me illustrate. Some years ago the need of protection from diphtheria was urgent. The infecting organism and its biological characters, on the one hand, were known; on the other, the dread disease was only too familiar. How could laboratory knowledge be used to solve the clinical problem? You are familiar with the answer which was given in the form of the diphtheria antitoxin. That is a splendid example of work in mediation as done in research institutes.

But a further question arises: How does the antitoxin produce its effect? This is quite another sort of problem; at first glance it appears to have little practical bearing and yet the answer to it in even one instance may lead to a wider view of the processes of immunity. The solution of problems of this class is different from the work of mediation, certainly of equal rank with it, and yet in every way harder to support and harder to carry on, since the results can not in the first instance possibly appeal to any save the well-trained few. In this there lies an obstacle to progress which you can largely help to remove.

Because the men who can do this latter kind of work are relatively rare, even among investigators, because such work can have rational appreciation from a limited group only, and because knowledge of this sort is sure to become the basis for many mediations in the future, it behooves us all to see to it that we foster such investigators—the most valuable of our natural resources. Perhaps it occurs to some of you that you have seen one well-known type of the man I here commend. Let me recall him to you.

An elderly gentleman with an unprogressive costume and unsteady gait, who generally fails to recognize his friends upon the street and requires several seconds to accomplish the recall when spoken to. Such is the mildly humorous picture with which all are familiar. It is often correct so far as it goes—only it is a bit incomplete.

One should add that this man is working with his head, a fact which accounts for almost everything and leaves us pondering why this symptom complex so readily excites remark.

Connected with the conduct of research in these foundations are several other problems of more than passing interest. The fear is sometimes voiced that in the absence of students, those at work will lack an important stimulus and suffer deterioration.

The danger varies with the man. Instances are known where men have failed to feel the attraction of institute opportunities, because they feared the loss of this companionship.

On the other hand, we have the attitude represented by the German university professor who is said to have remarked at the opening of the fall semester, "Now comes this disagreeable interruption of my work." Doubtless he was a wicked old dyspeptic, but for a moment he rose beyond himself and spoke for his burden-bearing caste.

Let me beg not to be misunderstood. I would not for a moment be thought to maintain more than the simple thesis that while teaching is a genuine stimulant to some, it is certainly a depressant to others and especially a depressant to those who are disturbed by interruption, so that some can drop it without damage to themselves.

In compensation it may be urged that the effect of the investigator's methods and personality is felt by those with whom he is usually surrounded, his colleagues and assistants, and when so surrounded he is in no more danger of isolation than a man in the university. However, that is not saying very much, for isolation among colleagues even in universities is a condition which we not only lament, but should also seek to change. It is an ancient tale.

The investigators of four centuries ago were chary of talking of their results and these were often published posthumously, as the authors preferred to die without assistance—or the new discoveries were sometimes couched in cryptic writings as though the author felt that what had given him such years of labor to find out should at least be hard for others to attain. That feeling is sometimes found to-day.

Once I remarked to a student, "Your thesis is three times too long." "Yes," he replied, "but if I did not make it long, how would any one know it had taken me two years to do the work." We can replace this by a better thought. The opportunity to satisfy one's longing for research is a noble privilege, but it brings its obligations. The advances thus made should be returned as rapidly as possible to the fund of common knowledge, and made accessible to the community at large.

This is essential for the progress of the plan, for most surely is the advanced worker dependent on his colleagues as they on him, and ultimately too he is in a larger sense also dependent on the community about him; so for both these reasons cooperation of the most complete sort is needful for the common good.

Expression has been given to the fear that the great resources of our research foundations would breed despondency among those who were compelled to work with simpler devices and less ample means, and thus they would do harm. Despondency and research do not dwell together.

Research is a frame of mind. A man may have little leisure and trifling resources, may never have published, but if he examines his world in a questioning spirit, if he carries with him not only conclusions, but the observations on which they rest, if he refuses to pound square facts into the round holes that he happens to have in hand, he has attained illumination. The spirit of research is nothing mysterious or remote, it is every-day hard sense. Unfortunately, that does not make it common, but it does make it attainable.

It would be a sorry outcome of these new foundations if they should act as hindrances to investigation in the university laboratories.

The fear that they will do this is often based on the false impression that the supply of scientific problems is limited and thus in danger of exhaustion. Let us be rid of that idea. Every advance creates new problems, problems of increasing importance—exhaustion is impossible.

By reason of the permanency of their programs and freedom from certain forms of responsibility, institutes may wisely undertake investigations of a sort hardly possible under university conditions. The field is thus divided, or rather enlarged. Both the university laboratories and the institutes should gain by this arrangement, and what is more, they do.

Before leaving this aspect of our problem, permit me to point out a peculiar advantage enjoyed by investigators who are working under university conditions. When we contrast the institutes with the universities, we find that it is within the walls of the university laboratory that it is most easy to carry on the search for new knowledge undisturbed by the thought of any applications which it may have.

In the face of some things already said, this statement may appear paradoxical—yet it describes a condition. In the judgment of the educated public, the teaching investigator fulfills his public obligations when he gives a stated amount of instruction. After that, there is a general feeling that the man should be allowed to follow his bent, and if this takes the form of research, the community does not feel obliged to inquire too closely concerning the practical value of the work. Thus in a way the university man is protected in his research by his teaching obligations, while the man in the institute, engaged in the same sort of investigation, is, if anything, more open to criticism, and at the same time without the defense which is possessed by his university colleague, and in so far he stands at a disadvantage.

As you see, I have been concerned in this address with medicine as represented by yourselves in relation to the research institutes, and that explains the manner of this presentation.

It has been my purpose to show that in these foundations we have something which represents an advance in our educational devices.

Their independence is an asset. They may be counted on to mediate in a measure between the initial facts of the laboratory and the problems presented by disease, but more important, though harder to maintain, is their function as laboratories where new knowledge is obtained, which in turn must have still wider applications.

All this concerns you who are just entering on your life work. You can receive direct benefits and enjoy new privileges by reason of these greater opportunities, but they also bring to you fresh responsibilities.

So far as any of you look upon these foundations from without it is my hope that some things have been said which will rouse in you a sympathetic appreciation of the kind of work which I have sought to emphasize as the most precious type of endeavor, for further progress will depend largely on the appreciation and support given to this by the best elements in the medical profession.

The material side of our advancing civilization has developed during a thousand years to an astonishing degree, but we must not be misled, as sometimes happens, into confusing material developments with intellectual progress. These foundations of to-day are but aids to active minds that use them. The mind, the man, is the essential thing, and any device which does not improve him and give him the very best opportunity to increase his powers, has but slight claim to our regard. I desire, therefore, to leave with you a strong impression of the paramount importance of our mental attitude in establishing the right relations between research foundations and medicine.

Permit me then in closing to quote a little fable from Luqman, as it seems to emphasize this point. Luqman, the sage, was reputed, I am told, to have been either an Abyssinian slave of King David or the son of Job's maternal aunt. That question is not settled—but his fable has a pleasant oriental flavor. It runs as follows:

In the heat of the day the lion retired to a cave. While resting there a rat ran over him. The lion jumped up in fright, whereat the jackal laughed. Perceiving this the lion said, "I was not frightened at the rat, but at my own alarm"; thus showing that to the mighty their state of mind is of more moment than death itself.

Henry H. Donaldson

FAMILY RECORDS OF GRADUATES OF WESLEYAN UNIVERSITY

FAMILY RECORDS OF GRADUATES OF WESLEYAN UNIVERSITY

Wesleyan University was founded in 1831, and the first class graduated in 1833. The total number of graduates, including the class of 1910, is 2,849—2,627 men and 222 women. The following statistics relating to married life are given separately for men and women. The first women graduates took their degrees in the decade 1871–80.

1. *Marriages*

In the first decade, 1833–40, 119 out of 142 graduates married (84 per cent.); 21 of them married twice, 3 of them three times, 1 of them four times and 1 five times. In the second decade, 1841–50, 217 out of 264 married (82 per cent.); 47 married twice, 4 three times and 1 four times. In the third decade, 1851–60, 250 out of 276 married (90 per cent.); 50 married twice, 5 three times and 1 four times. From 1861–70, 239 married out of 262 (again 90 per cent.); 37 married twice and 6 three times. In the fifth decade, 1871–80, 271 out of 311 male graduates married (87.1 per cent.); 41 married twice and 1 three times. Five out of the 8 women graduates in this decade married. In the sixth decade, 1881–90, 268 out of 340 of the men married (78.82 per cent.), 14 of them having married twice. Fourteen out of the 29 women graduates of this decade married, that is, 48 per cent. In the seventh decade, 1891–1900, 344 out of the 461 male graduates married (74.62 per cent.); 10 of them married twice. Fifty-one women out of the 95 who graduated in this decade married (53.68 per cent.). In the last decade, 1901–10, 221 men out of 570 have so far married (38.8 per cent.); 3 of them have married twice. Twenty-six out of the 90 women who graduated in this decade have married (28.8 per cent.).

Of the 2,627 male graduates, 1,930 have married (73.46 per cent.). Of the 222 women graduates, 96 have married (43.28 per cent.). The percentage of married women compared with that of men who graduated in their own classes and have married, is 43.48 per cent. as against 65.7 per cent.

TABLE I

Percentage of Graduates Married

Classes	Men	Women
1833–40	84	—
1841–50	82	—
1851–60	90	—
1861–70	90	—
1871–80	87.1	62.5
1881–90	78.82	48
1891–1900	74.62	53.68
1901–10	38.9	28.8

2. *Children*

In the first decade, 1833–40, from 119 marriages of graduates there were 535 children, 275 boys and 260 girls, an average to the family of 4.49; one family comprised 12 children, four 11 children, four 10 children, and there were only eight childless marriages. In the second decade, 1841–50, from the marriage of 217 graduates there were 750 children, 398 boys and 352 girls, an average to the family of 3.46; there were three families of 10 children each, one of 11 and thirty-two childless marriages. In the third decade, from the marriage of 250 graduates there were 818 children, 396 boys and 422 girls, an average of 3.27; one family consisted of 13 children, one of 11 and one of 10; there were twenty-six childless marriages. In the fourth decade, from 239 marriages there were 688 children, 360 boys and 328 girls, an average of 2.9 to a family; there was one family of 10 children, and there were thirty-two childless marriages. In the fifth decade, 271 male graduates who married had 686 children, 374 boys and 312 girls, an average of 2.53; there was one family of 10 children and two of 9, and there were forty-five childless marriages. The 5 women graduates of this decade who married had 13 children, 7 boys and 6 girls, 8 of the 13 being already reported in the figures of this decade, inasmuch as they were children of women graduates who married graduates of Wesleyan. The average number of children to a marriage of the women graduates was 2.6. In the sixth decade, 1881–90, the 268 male graduates who married had 527 children, 289 boys and 238 girls, an average to a family of 1.96; there was only one large family, made up of 11 children. The 14 women graduates of this decade who married had 28 children, 13 boys and 15 girls, 10 of the 28 being previously reported in the decade owing to intermarriage of Wesleyan graduates; the average to a family in the case of the women graduates of this decade was 2. In the seventh decade, 344 men who married had 488 children, 250 boys and 238 girls, an average to the family of 1.42; there was one family of 8 children. The 51 women graduates of this decade who married had 70 children, 35 boys and 35 girls, 42 of them being previously reported, an average for the women graduates who married in this decade of 1.37. In the last decade, 1901–10, the 222 men who have married have had 180 children, 94 boys and 86 girls, an average to the family of .81; the largest family reported so far is 3. The 26 women of this decade who have married have had 18 children, 7 boys and 11 girls, 10 of them being reported in the 180 above mentioned; the average family to the married women graduates of this decade is to date .69.

TABLE II

Average Number of Children to a Family

Classes	Men	Women
1833–40	4.49	—
1841–50	3.46	—
1851–60	3.27	—
1861–70	2.9	—
1871–80	2.53	2.6
1881–90	1.96	2
1891–1900	1.42	1.37
1901–10	.81	.69

The total number of children of male graduates of Wesleyan to date is 4,672, 2,436 boys and 2,236 girls, an average to the family of 2.42. The total number of children of women graduates who have married is 129, 62 boys and 67 girls, an average to each married woman of 1.34. On account of the large families in the early days, when there were no women graduates, the comparison should, however, be made between men and women of the same graduating classes. The average number of children of the married men in the same classes as the women is 1.7 as compared with 1.34 for the women. The total number of children of Wesleyan alumni, men and women, excluding duplicates, is 4,731. Of these 1,076 have been reported dead.

Frank W. Nicolson

AN INDEX OF FISH ENVIRONMENTS

In studying the distribution and success of fishes within a given area, one often notes the absence of certain species from localities which appear quite suitable fish habitats upon inspection, or even upon determination of the oxygen content of the water. Evidently, the causes of this absence is not a life and death matter such as is often supposed to be true in animal distribution. But since fishes are able to move readily from place to place, they may leave or fail to enter a locality where the conditions are entirely compatible with life for a longer or shorter period. Yet the change in conditions may be great enough to cause the fishes either to turn back or to leave the locality because of stimulation and increased activity. Wishing to test this reaction possibility, we devised a means of studying the behavior of fishes when they encounter differences in gases or solids in solution. The apparatus consisted of a device giving a constant flow of water with desired amounts of dissolved gases, and at any temperature within ordinary experimental needs. Two tanks, 120 cm. long by 20.5 cm. wide by 14 cm. deep were arranged under identical and symmetrical surrounding conditions. Water was introduced into both ends of the tanks at the same rate and was allowed to flow out at the center. The same kind of water was introduced into the two ends of the control tank. In the experimental tank the water introduced at one end was like that of the control, while the gas content of that introduced at the other end had been experimentally modified. This established a gradient between the two kinds of water. Fishes put into the tanks tend to go back and forth and thus encounter the experimental gradient. When the change of conditions thus encountered was such as to affect the fishes, they reacted either by turning back or by passing through the gradient into the treated water. But in this case they quickly returned to the untreated water, thus spending a shorter time in the treated water.

Eight species of fish, widely separated taxonomically, were studied in detail. All the fishes were slightly negative or indefinite in their reaction to differences in oxygen content. We found no good evidence that they react to nitrogen. Their reaction to water which had lost six parts per million of its salts (mainly magnesium and calcium), 15 c.c. of nitrogen and 2 c.c. of carbondioxide per liter by boiling was about the same as to difference in oxygen content. All the fishes were decidedly negative in their reaction to increased carbon dioxide. The differences tried varied from 5 to 60 c.c. per liter above that in which the fish had been kept. When increased carbon dioxide accompanied low oxygen the negative reaction was very marked; the fishes turned back when the gradient was encountered and only rarely entered the part containing the highest carbon dioxide and lowest oxygen.

Several workers have shown that carbon dioxide is very toxic to fish. It appears to be much more so than corresponding differences (24 c.c. per liter) in oxygen content. Fishes turn away when they encounter an increase of as little as 5 c.c. per liter. Since a large amount of dissolved carbon dioxide is commonly accompanied by a low oxygen content, and other important factors, the carbon dioxide content of water (strongly alkaline waters excepted) is probably the best single index of the suitability of that water for fishes. The methods and these results, as well as others, will be published in detail elsewhere as soon as they can be prepared. These aspects of the results are sufficiently different from what workers appear to have been expecting to justify their publication here on account of possible bearing on field studies during the present season.

V. E. Shelford,
W. C. Allee

THE RELATION OF THE HORSEPOWER TO THE KILOWATT [1]

There was, before 1911, no precise definition of the horsepower that was generally accepted and authoritative, and different equivalents of this unit in watts are given by various books. The most frequently used equivalent in watts, both in the United States and England, has been the round number, 746 watts; and in 1911 the American Institute of Electrical Engineers adopted this as the exact value of the horsepower. It is obviously desirable that a unit of power should not vary from place to place, and the horsepower thus defined as a fixed number of watts does indeed represent the same rate of work at all places. Inasmuch as the "pound" weight, as a unit of force, varies in value as g the acceleration of gravity varies, the number of foot-pounds per second in a horsepower accordingly varies with the latitude and altitude. It is equal to 550 foot-pounds per second at 50° latitude and sea level, approximately the location of London, where the original experiments were made by James Watt to determine the magnitude of the horsepower.

The "continental horsepower," which is used on the continent of Europe, differs from the English and American horsepower by more than 1 per cent., its usual equivalent in watts being 736. This difference is historically due to the confusion existing in weights and measures about a hundred years ago. After the metric system had come into use in Europe, the various values of the horsepower in terms of local feet and pounds were reduced to metric units and were rounded off to 75 kilogram-meters per second, although the original English value was equivalent to 76.041 kilogram-meters per second. Since a unit of power should represent the same rate of work at all places, the "continental horsepower" is best defined as 736 watts; this is equivalent to 75 kilogram-meters per second at latitude 52° 30′, or Berlin. The circular gives tables showing the variation with latitude and altitude of the number of foot-pounds per second and of kilogram-meters per second in the two different horsepowers.

These values, 746 and 736 watts, were adopted as early as 1873 by a committee of the British Association for the Advancement of Science. The value, 0.746 kilowatt, will be used in future publications of the Bureau of Standards as the exact equivalent of the English and American horsepower. It is recognized, however, that modern engineering practise is constantly tending away from the horsepower and toward the kilowatt. The Bureau of Standards and the Standards Committee of the American Institute of Electrical Engineers recommend the kilowatt for use generally instead of the horsepower as the unit of power.

[1] Abstract of Circular of the Bureau of Standards, No. 34; June, 1912.

THE IMPERIAL UNIVERSITIES CONGRESS

The Imperial Universities Congress was opened by Lord Rosebery on July 2, at the University of London, South Kensington. As we learn from the reports in the London *Times* the question of the division of work and specialization among universities was dealt with in a paper by Sir Alfred Hopkinson, and Sir Arthur Rücker and Sir Charles Waldstein spoke on the same subject. Principal Peterson, of McGill University, introduced a discussion on inter-university arrangements for post-graduate and research students.

On July 3 there were two sessions of the congress, Lord Curzon of Kedleston presiding in the morning and Mr. Balfour in the afternoon. Papers were read on the relation of the universities to technical and professional education, the interchange of university teachers, and the problem of universities in the east. The speakers and readers of papers included Sir Frederick Lugard, Sir Isambard Owen, Dr. A. E. Shipley, Sir Thomas Raleigh and

Professor Patrick Geddes. Lord Rayleigh and Lord Haldane presided on July 4, and among others Principal W. H. Hadow, Sir Edward Busk and Sir George Gibb were on the program. On Friday, when Lord Strathcona presided, Dr. G. R. Parkin and Sir Alfred Keogh dealt with the question of the establishment of a central bureau, Mrs. Sophie Bryant, Mrs. Sidgwick, and others with the position of women in universities, and Sir James Donaldson and Mr. Michael Sadler with the representation of teachers and graduates on the governing body of a university. The entertainments included a luncheon at the invitation of the government, a reception of delegates by Prince Arthur of Connaught at the University of London, dinners at the halls of several city companies and an "At Home" at the Mansion House.

SCIENTIFIC NOTES AND NEWS

Cambridge University has conferred the degree of doctor of science upon Edwin Brant Frost, director of the Yerkes Observatory.

Among newly created doctors of laws of the University of Edinburgh are Dr. J. S. Phelps, of the Geological Survey, and Professor J. Theodore Cash, F.R.S., professor of materia medica, University of Aberdeen.

Durham University has conferred its doctorate of science on Professor Prafulla Chandra Ray, dean of the faculty of science in the University of Calcutta; Professor L. P. Anderson Stuart, professor of physiology and dean of the faculty of medicine in the University of Sydney.

Cambridge University will confer the degree of doctor of science on Dr. Howard Marsh, professor of human anatomy in the university and master of Downing College.

Dr. R. T. Glazebrook, F.R.S., director of the National Physical Laboratory, has been elected president of the Faraday Society.

At the seventy-eighth annual general meeting of the Royal Statistical Society, Professor F. Y. Edgeworth was elected president.

The *Journal* of the American Medical Association states that the friends, the pupils and ophthalmologists of many countries united recently in celebrating the seventy-seventh birthday of Professor Henri Dor, by presenting him with a portrait medal. The reverse of the medal typifies Dor's life-work, as it represents science pushing back the clouds that the light can fall on the child beside it. The background shows Dor's home on the banks of the Rhone at Lyons where he has been professor of ophthalmology since 1876. He was a pupil of both Graefe and Donders, and founded thirty years ago the *Revue Générale d'Ophthalmologie.*

A new office, that of administrative geologist, has been created on the U. S. Geological Survey, and Dr. George H. Ashley, Ph.D. (Stanford, '94), chosen to fill it. This position is virtually vice-director of the survey, placing the incumbent in complete charge of the organization during the absence of the director, and in addition giving him charge of certain functions of the organization the whole time. Dr. Ashley has been a geologist of the survey since 1901 except for the years 1910 and 1911, when he was state geologist of Tennessee.

The following promotions to the rank of geologist of the U. S. Geological Survey have been made: Robert Anderson, B. S. Butler, Adolph Knopf, F. H. Moffit, G. B. Richardson and A. R. Schultz.

Dr. Chester A. Reeds, for the past four years lecturer and associate in geology at Bryn Mawr College, has been appointed assistant curator of the department of geology and invertebrate paleontology of the American Museum of Natural History. He enters upon his new duties August first, after spending some weeks in Europe visiting museums.

Mr. F. W. Jones, has been appointed chief chemist of the purification works of the Fitchburg, Massachusetts, Sewer Department. Mr. Jones was for some time instructor in chemistry at the Worcester Polytechnic Institute. During the past year he has been assistant chemist at the Worcester sewage purification works.

AT a meeting of the Lawes Agricultural Trust Committee, held on June 25, Dr. E. J. Russell, at present Goldsmiths' Company's assistant for soil investigations, was appointed director of the Rothamsted Experimental Station in succession to Mr. A. D. Hall, F.R.S.

THE Mackinnon studentships of the Royal Society for the ensuing year have been awarded to H. M. Kyle, D.Sc. (St. Andrews), for a research on the metamorphosis and origin of the flat fishes, and to Mr. A. L. Hughes, Emmanuel College, Cambridge, for a research on the ionization in mercury vapor produced by ultra-violet light.

THE special board for biology and geology of Cambridge University has nominated Mr. G. R. Mines, M.A., Sidney Sussex College, and Mr. H. M. Fuchs, B.A., Gonville and Caius College, to use the university table at Naples, and Mr. James Gray, B.A., King's College, to occupy the university table at the Laboratory of the Marine Biological Association at Plymouth.

PROFESSOR S. A. MITCHELL, of Columbia University, will spend a year at Yerkes Observatory.

PROFESSOR THEODORE LYMAN, of Harvard University, has gone to the Altai Mountains, on the borders of Siberia and Mongolia, on a hunting expedition. He takes with him Mr. N. Hollister, assistant curator at the National Museum, Washington, who will make zoological collections to be divided between that museum and the Harvard Museum of Comparative Zoology.

ASSOCIATE PROFESSOR FREDERICK STARR, of the University of Chicago, sailed on June 20 for Africa on an expedition for anthropological research. After a visit to Morocco and the Canary Islands, Professor Starr and his party will go directly to Liberia, and thence into the back country, where they will spend the rest of the year, returning about January 1, 1913.

DR. HERBERT MÜLLER, of the Anthropological Museum in Berlin, has gone to China for ethnological researches in Manchuria and eastern Mongolia.

MR. R. H. HOOKER, M.A., has been appointed Newmarch lecturer in statistics at University College for the session 1912–13. The subject of his lectures will be "The Food Supply of the United Kingdom."

LEONARDO DA VINCI'S contributions to the principles of aviation were celebrated in Paris on July 4, when addresses were made by the French prime minister and the Italian ambassador.

THE session of the Chemical Society, London, for 1912–13 will open on October 17 with a memorial lecture in honor of Antoine Henri Becquerel, late honorary and foreign member of the society, to be delivered by Sir Oliver Lodge, F.R.S.

MR. WILLIAM R. SMITH, for sixty years superintendent of the National Botanical Garden, died at Washington on July 7, aged eighty-four years.

PROFESSOR ORVILLE BRIGGS STACY, for forty-two years a member of the faculty of the Brooklyn Polytechnic Institute, holding the chair of natural science and mathematics at the time of his retirement in 1906, has died at the age of eighty years.

DR. THOMAS H. BACHE, great-great-grandson of Benjamin Franklin, a distinguished physician of Philadelphia, has died at the age of eighty-six years.

THE board of trustees announces that the next annual session of the American Medical Association will be held in Minneapolis from June 17 to 20, 1913.

A RECENT addition which has been made to the equipment of the Colorado School of Mines is a new 14-foot Littrow spectrograph, purchased at a cost of $1,500, through the Vinson Walsh research fund. This fund was given by the late Thomas F. Walsh for the determination and study of rare metals in ores.

A valuable collection of 117 Hawaiian birds has been presented to the University of California by Miss Annie M. Alexander, for inclusion in the California Museum of Vertebrate Zoology. The clearing of forest lands for cultivation in the Hawaiian Islands has resulted in the entire extinction of some of the species represented, so the collection is especially important.

UNIVERSITY AND EDUCATIONAL NEWS

The late Mr. C. D. Borden, of New York City, has bequeathed $250,000 to Yale University, from which he graduated in 1864. The clause in his will reads: "I make this bequest without any restrictions, as I have long been of the opinion that the said corporation did not have sufficient funds to provide adequately for its general expenses and especially for proper payment of its instructors."

Mr. John Armstrong Challoner has conveyed his property in trust, making the University of Virginia and the University of Carolina his residuary legatees, and giving $10,000 to each of nine other educational institutions.

Lord Haldane has opened the new Harrison-Hughes Engineering Laboratories at Liverpool University, erected by a gift of about £40,000 from Mr. T. F. Harrison, Mr. J. W. Hughes and Mr. Heath Harrison, the Liverpool shipowners.

It has been decided to establish a chair of agriculture in the University of Queensland, toward which Mr. Robert Philp has offered to give £1,400 and Mr. R. M. Christison £1,000.

Mr. Walter Morrison, of Baliol College, has given £10,000 to Oxford University for the promotion of the study of agriculture.

The late Dr. A. W. Verrall, King Edward VII. professor of English literature at Cambridge, left, subject to the life interest of his wife, £1,000 to the university absolutely, and £1,000 to Trinity College absolutely.

An addition is being made to the Agricultural Building of the University of Illinois by enclosing the court. The structure will be only one story high and will have cement floors. It will provide reading room, class rooms, museum, etc.

The Medical School of Trinity College, Dublin, celebrated the bicentennial of its foundation on July 5. Seventy-eight addresses were presented by delegates from other institutions.

Dr. Robert Sharp, dean of the graduate department of Tulane University, has been elected acting president of the university, succeeding Dr. Edwin B. Craighead, who recently resigned to become president of the University of Montana.

Dr. William Pepper, professor of clinical pathology at the University of Pennsylvania, son of the former provost of the university, has been appointed dean of the Medical Department, to succeed Dr. Allen J. Smith, resigned. Dr. Smith will remain professor of pathology, comparative pathology and tropical medicine.

Dr. Thomas F. Hunt, director of the School of Agriculture of the Pennsylvania State College, has been appointed to succeed Dr. E. J. Erickson, dean of the College of Agriculture of the University of California.

Dr. Arthur I. Kendall, Boston, has been placed in charge of the research work on tuberculosis in Northwestern University, the chair for which was recently endowed with $250,000 by James A. Patten, Evanston, Ill.

E. N. Zern, recently professor of coal mining at the University of Pittsburgh, has been appointed professor of mining at West Virginia University, Morgantown, W. Va.

Ansel F. Hemenway, of the University of Chicago, has been appointed professor of biology and geology at Transylvania University, Lexington, Ky.

Dr. Otto Glaser has been promoted from an assistant professorship in zoology to the rank of junior professor at the University of Michigan, and has been granted $275 for equipment for his studies on the energetics of embryogenesis.

The following appointments have recently been made to the faculty of the College of Agriculture, University of Porto Rico: Mr. C.

L. Lang, professor of mathematics and physics; Mr. W. Ramirez, professor of Spanish; Miss E. Prat, instructor in biology.

THE Agricultural College of Utah announces the organization of a course in agricultural engineering with departments of irrigation and drainage, road building, farm machinery, farm buildings, hydraulics, rural sanitation and public health. The following appointments to the faculty have been made: R. B. West, C.E. (Cornell), professor of engineering, and Frank Daines, A.M. (Harvard), professor of history, to succeed Professor Harrison Dale, who has accepted a similar position in the Washington University at St. Louis.

THE Syracuse University Medical School has called the following men to its corps of instruction: as assistant professor of bacteriology, Leverett Dale Bristol, A.B., M.D. (Johns Hopkins), of St. Paul, Minn.; as instructor in the department of histology, Earl V. Sweet, A.B., M.D. (Cornell), of Phœnix, N. Y.; as instructor in surgery, Albert G. Swift, M.D. (Syracuse), of New York City; as instructor in pathology, John W. Cox, M.D. (Syracuse). This position was secured by scholarship. At the suggestion of the dean, Colgate University has signified its intention of permitting students to take the senior year in a registered medical college *in absentia,* such students to receive the bachelor's degree upon the presentation of a certificate from the college of medicine attended to the effect that his work has been done satisfactorily.

DR. H. K. ANDERSON, F.R.S., fellow of Gonville and Caius College, Cambridge, known for his research on the physiology of the nervous system, has been elected master of the college, in succession to the late Rev. E. S. Roberts.

MISS JANET LANE-CLAYPON, M.D., D.Sc. (London), lecturer in hygiene and physiology at Battersea polytechnic, has been appointed lecturer in hygiene and physiology at King's College for Women, London.

THE following appointments have been made at the University of Manchester: Richardson lecturer in mathematics, Mr. W. D. Evans, M.A., now lecturer in mathematics at Hartley College, Southampton; junior assistant lecturer in physics, Mr. Harold Robinson, B.Sc.; demonstrators in anatomy, Mr. J. B. Stopford, M.B., and Mr. Manfred Moritz.

DISCUSSION AND CORRESPONDENCE

PHILIPPINE SHARKS

TO THE EDITOR OF SCIENCE: I have just received two memoirs on Philippine sharks by Dr. H. M. Smith.[1] In the first of these *Pentanchus profundicolus* is described as a new genus and species, and the representative of a new family of Notidanoids; in my opinion this fish belongs to the family Scyliorhinidæ, and if, as I suspect may be the case, the absence of the first dorsal fin is abnormal or accidental, it is a *Scyliorhinus* closely related to the species numbered 11 to 14 in my synopsis.[2] The second paper deals with the Squalidæ, and on comparing with my synopsis[3] I find that the new genus *Nasisqualus* corresponds to a section of *Centrophorus* which has already received the names *Acanthidium* and *Deania;* a second new genus, *Squalidus,* is valid, differing from *Euprotomicrus* in the structure and position of the first dorsal fin.

C. TATE REGAN

BRITISH MUSEUM (NATURAL HISTORY)

ARAGONITE COATING GRAVEL PEBBLES

TO THE EDITOR OF SCIENCE: On a trip to Clinton, Massachusetts, with Professor George H. Barton, I found in a gravel pit, directly opposite the station, a number of large pebbles with the white coating of calcium carbonate that one often sees. A hemispherical radiate growth up to 5 mm. long, at certain points, attracted my attention, and I took a couple of pebbles home. The coating, to my great surprise, proved both by Meigen's test with cobalt nitrate and by optical tests (-ex. o cleavage parallel elongation) to be aragonite.

Though I have made no goniometer investigation, the divergent prismatic crystals with

[1] *Proc. U. S. Nat. Mus.*, XII., 1912.

[2] *Ann. Mag. Nat. Hist.* (8), I., 1908, p. 453.

[3] *Ann. Mag. Nat. Hist.* (8), II., 1908, p. 39.

striated ends appear to be bounded by *b*, *m* and *k*, as well as other faces.

I am now wondering how commonly such coatings are aragonite rather than calcite.

Alfred C. Lane

Tufts College, Mass.,
June 18, 1912

SCIENTIFIC BOOKS

Theoretical and Physical Chemistry. By S. Lawrence Bigelow, Ph.D., Professor of General and Physical Chemistry in the University of Michigan. New York, The Century Co. 1912. 14 × 22 cm. Pp. xiii + 544. Price $3.00.

In his preface, the author points out that, after gaining some knowledge of the facts in the first year or two's study of chemistry, students are ready to find both profit and pleasure in a more philosophical study of generalizations and principles than was possible at an earlier stage. Truly, the modern beginners' course in general chemistry, although it is in part descriptive and detailed, yet fully deserves the appelation "general" in Ostwald's sense, and might well have served for a course in physical chemistry some fifteen years ago (p. 4). Selecting the generalizations from the masses of details accumulated in all the special branches of chemistry, however, "our subject makes a specialty of these generalizations," and therefore stands to chemistry in the same relation as philosophy does to all sciences. Instead of "Theoretical and Physical Chemistry," the book might, indeed, have well been entitled "The Philosophy of Chemistry," if for no other reason because of the catholic and philosophic viewpoint of its author. After reading his prefatory acknowledgments to his former teachers Ostwald and Nernst, one looks rather for Germanic philosophy; but what one finds is Anglo-Saxon. For those who require to have this distinction characterized for purposes of physical science it may be stated, with Duhem, that the Anglo-Saxon temperament wishes to construct a tangible model of sticks and strings, while the Germanic carries the logic to its necessary conclusion, however unfathomable.

In regard to the subjects treated, any criticisms as to omissions is disarmed by the statement that "the most difficult part of the task has been the selection of topics to omit." In spite of well-chosen omissions, however, a very wide field is nevertheless covered, lightly, often with elegance and always with clearness. The titles of some of the thirty chapters which the book contains are as follows: The Scientific Method; Fundamental Definitions; Unit Quantities of Chemistry and Chemical Notation; Chemical Energy, Affinity and Valence; Spectroscopic Evidences and the Theory of Inorganic Evolution; Luminiferous Ether and Vortex Rings; Radioactivity and the Electron Theory; Solid Solutions; Colloidal Solutions; Liquefaction of Gases; Some Elementary Thermodynamic Deductions; Actinochemistry. In an elementary text, beaten tracks have, in the main, to be followed, for "classifications and methods of presentation which have proved satisfactory by their results should not be tampered with unless for clearly good cause. My colleagues will therefore recognize many familiar statements and arrangements in the following pages"—which remark again disarms criticism of the author, at least, for an occasional misstatement. Examples of the side-heads to paragraphs may serve to show that the topics selected for treatment are not by any means identical with those common to other similar text-books; such side-heads are: Relativity Principle, Table of Energies and their Factors, Landolt's Experiments, Significance of Valence, Archimedes Spiral [of the elements], Protyle, Emission of Light and Temperature, Stefan's Law, Bolometer, Proto-elements, Zeeman Effect, Canal Rays, The Value of *e/m*, Stokes' Law, Siendentopf and Zsigmondy's Results, Brownian Movement, Kundt's Method, "Etch Figures," Agglutination, Three Ways to Damage a Storage Cell, etc. The paragraph on page 141 on the deduction of Avogadro's theory might, by the way, be omitted or modified in the light of Rayleigh's note on page 326 of Maxwell's "Heat."

After all, the manner, in an elementary text, is perhaps even more important than the matter. Preeminently throughout, the manner is one of friendliness to the student; and, as one reads, one senses constantly the author's mental attitude of regret that our accepted terminology has been confusing or that the subject can not be made even plainer than a pikestaff. In the preface we read, ". . . most earnest efforts have been directed to show the inherent simplicity of some ideas . . ."; and it may truly be said that these efforts have been, in the main, remarkably successful.

The publishers have done their work well, and the book is excellently produced and unusually free from *errata*. There can be no doubt that this is the best text-book in its range and field that has yet appeared.

Alan W. C. Menzies

In Northern Labrador. By William Brooks Cabot. R. G. Badger. Illustrated. $2.50.

Among the Eskimos of Labrador. By S. K. Hutton. J. B. Lippincott Co. Illustrated $3.50.

These are two notable books about a little-known country, which give valuable and interesting information as to the life conditions and the racial characteristics of its aboriginal peoples. The interesting volume by the American regarding the Indians of the central inland district is well balanced and supplemented by the English doctor's detailed accounts of the Eskimos of the northern coasts.

Most readers will find specially attractive the well-written, beautifully illustrated volume by Mr. Cabot, who prefaces his experiences by a brief, admirable summary of previous explorations. While he has many times visited Labrador the book confines itself to accounts of five visits, wherein he acquired some facility in Indian speech, and became familiar with the social, domestic, travel and hunting methods of both the Eskimo and Indians.

He outlines Grenfell's great work in a sentence: "He represents the modern humanities on a coast where before they were peculiarly lacking." With artistic appreciation he writes: "The bergs are gigantic crystalline masses, pure elemental separations, the like of which neither land nor sea has to show in any other form. In some lingers the greater design, foundation, plinth and shaft. The gods of the North had their temples and these are their fragments." Vegetation and landscape, birds and beasts, fish and mankind all appeal to his observing mind.

The illustrations from photographs are excellent, and well chosen, adequately representing the land and the people.

The data obtained on Lake Mistinipi, an affluent of George River, as to the Naskapi Indians are valuable. Tersely they are described as untamed aborigines, of the stone age, of unmodified raciality, thin-legged, wiry, with horse-tail hair. The typical photographs and ethnographic details are of special interest.

The appendix on mice will be read by scientists with pleasure. His remarks, on the intimate interrelations between the humbler forms of life and seasons of want and plenty for the higher forms, will be noted with interest. The volume is a welcome addition to our knowledge of this inhospitable land.

Dr. Hutton's hospital service of five years among the eskimos of extreme northern Labrador has enabled him to produce quite a remarkable book. With these aborigines he has "come in closest contact in their homes, in their work, in their hunting and their journeys, in health and in sickness." More than thirty reproductions of photographs, with notes, afford clear ideas of the features, dress, and life conditions of these Children of the Ice. There are interesting descriptions of weddings, seal-hunting, walrus-killing, fur-trapping, reindeer-hunting, tent and igloo life, child training, etc. An adventurous touch is given in a sledge journey wherein the author was lost on a mountain-crossing, in a violent snow storm. In short the volume is filled with information as to the present condition of the eskimos of Labrador that will be most acceptable not only to the general reader, but to ethnologists. Specially noteworthy is the account of the semi-heathen natives of Killinek, the most northerly point of Labrador, with its decrepit old chief, Tuglavi.

The Killineks "are more weather-beaten than those farther south, as they live mainly in snow-huts and tents, without fires, cheerfully enduring the most terrible climate imaginable." They are gradually coming under missionary influences, to their marked benefit.

It is pleasant to know from such authority that the eskimos of Labrador are living cleanly and under moral conditions, that they have elected elders who control quietly and effectively the whole community. Crime is practically unknown, and the success in banishing liquor-making is a notable instance of their power of self-government. Most persons will be surprised to learn that in literacy the eskimos of Labrador surpass the people of the United States, for, we are told, every eskimo child above twelve years of age can read and write. Every year an eskimo paper is published, and from time to time pamphlets, etc., in the native dialect. They are "a kindly, hospitable people, quick to anger and quick to forgive." The Moravian missionaries have wisely urged the continuance of native methods as to dress, customs and food.

Altogether these two volumes are among the most valuable that have appeared relative to American aborigines in several years.

A. W. Greely

Reminiscences of the Yukon. By the Hon. Stratford Tollemache. Longmans, Green and Co. Illustrated. $3.50 net.

The Conquest of the Great Northwest. By Agnes C. Laut. New ed. 2 vols. in one. Moffat, Yard and Co.

The new and cheaper edition of the "Conquest of the Great Northwest" will be most acceptable to the many desirous of possessing this vividly told story of the Hudson Bay Company, with the preliminary voyages of Henry Hudson, and the rise of the opposition Northwest Company.

The passing of the Hudson Bay Company, and the supplanting of its fur-trade by the gold-seekers of the Yukon Valley, naturally transformed the economical and human history of northwest arctic America. Well told as it is, few now take special interest in the account of the Klondike rush in 1898, the upbuilding of Dawson, and the extension of gold discoveries in adjacent regions. These events marked an epoch that has been told and retold in many scores of volumes.

Mr. Tollemache has, however, made a most acceptable addition to life in the Yukon in his reminiscences of eleven years of frontier existence. His experiences on the Pelly and McMillan rivers as a trapper cover a phase of frontier life of which little has been published. His accounts of the methods followed in trapping, and remarks on the game of the country —fish, fowl and beast—are contributions to an accurate knowledge of the natural history of the Yukon watershed that will be eagerly read.

Probably the most interesting chapter in the volume, certainly so to scientists, is that on color protection and big game, though a disappointingly small part is devoted to the color scheme. The account of the Indians is discouraging to the well-wishers of the aborigines, but doubtless correct in its general features. The illustrations are of interest in their presenting methods of trapping with which most general readers are unfamiliar.

A. W. Greely

Sewage Disposal. By George W. Fuller. New York, McGraw-Hill Book Co. 1912. Pp. 767.

This book is, according to the author's preface, a resumé of the progress that has been made in this country during the last quarter century by one who has been intimately associated with the work. No one could be better qualified to write such a book than Mr. Fuller and no better book on the subject has been written. Its nearly eight hundred pages make a very formidable document, but the dismay of the reader will vanish when he discovers that the material is excellently arranged, clearly printed and paragraphed, and well indexed. Brevity has been sacrificed to clearness, and repetition has been employed for the sake of emphasis. The principal reason for the size of the book, however, is that the author has, as he says, drawn fully from the writings of others and from the professional papers and reports of the firm of which he was so long a member. Some might have wished these quotations to have been abstracted and condensed, but most engineers will very much appreciate having so many important works set forth in such a convenient form for reference. While the author has quoted largely he has not failed to express his own ideas on most questions at issue. On matters of doubt he has set forth the arguments and opinions of experts on both sides.

Perhaps the most commendable feature of Mr. Fuller's book is his point of view. It is not a mere description of methods used for attempting to purify sewage, it is far broader than that. This is shown by the fact that fully half of the book is devoted to the composition of sewage, its decomposition, sewage bacteria and the disposal of sewage without treatment into inland streams, lakes and tidal estuaries. It is again shown by the use of the term "sewage treatment" in place of the misused and very misleading term "sewage purification." This change the reviewer heartily approves and believes that it alone will do much to place the matter of sewage disposal in the right light for those who are interested in the subject from a sanitary standpoint only. The sooner that the medical fraternity and the health officers realize the limitations in the sanitary efficiencies of some of the processes of treatment employed, the more rapid will be the rational development of the art. The point of view of the author is expressed by the opening words of the sixth chapter, where he says "the disposal of sewage by treatment in works of artificial construction becomes necessary in some cases through the failure of the dilution method to meet local requirements." And again in the last chapter, where he says: "One of the most conspicuous facts to be borne in mind is that there is no standard method of procedure for the treatment of sewage, which can be uniformly applied to a large number of problems with a view to securing satisfactory hygienic results at least cost. Various partial methods, arrangements or devices are suitable in some combination or another for a large number of problems. But there is no cure-all or appliance which can be installed for all problems. Each set of local conditions should be carefully studied, in order to secure proper hygienic efficiency with due regard for economy of construction and operation, before new works are adopted, or extensions made to existing works."

Another good feature of the work is its historical point of view. The reader can not fail to be impressed with the fact that the art of sewage treatment has been a gradual evolution of methods to fit particular conditions and that there are yet many problems to be solved. Nor can he fail to observe how the advances in scientific thought in the realm of bacteriology and physical chemistry are profoundly affecting actual practise. An entire chapter is devoted to the development of experiment stations and a table is given showing that during the last twenty-five years nearly $900,000 has been spent in this country for experimental studies relating to the purification of water and sewage. Especial tribute is paid to the pioneer researches of the Massachusetts State Board of Health Experiment Station at Lawrence. The historical aspect of the book is well shown in the treatment of the problem of sewage disposal in the harbors of Boston and New York.

It is probable that the first half of the book, in which the more general aspect of the disposal of sewage by dilution is considered, will be more appreciated by engineers than the second half, devoted to methods of treatment, for the reason that data regarding the former subject have never before been so thoroughly compiled. The layman, however, will derive benefit from the systematic descriptions of processes in the second half of the book.

To describe the book more specifically, there are twenty-six chapters, devoted to the following subjects: Composition of Sewage; Aerobic and Anaerobic Decomposition of Sewage; Sewage Bacteria as Related to Offensive Odors; Sewage Bacteria as Related to Public Water Supplies; Sewage as Related to Shellfish; the Problem of Sewage Disposal; Experimental Methods as Applied to Sewage Disposal Problems; Dilution in Inland

Streams; Dilution in Large Lakes; Dilution in Oceans and Tidal Estuaries; Sewage Treatment Works; Screening; Plain Sedimentation; Septicization in Connection with Sedimentation; Chemical Precipitation in Conjunction with Sedimentation; Electrolytic Treatment; Strainers, Slate Beds and Colloidors; Broad Irrigation; Intermittent Sand Filtration; Contact Filters; Sprinkling Filters; Aeration; Hypochlorite Treatment; Ozonization; Institutional and Residential Plants; Comparative Summary.

It will be noticed that some of the newer processes, such as ozonization, the use of electrolytically prepared hypochlorite, etc., are also gone into, but with reservations as to their probable utility. In the description of processes, emphasis has been placed on the underlying principles and on the efficiencies obtained by their application, while structures have been described only to a limited extent and the illustrations are relatively meager, The subject of cost is also one that has not been elaborated.

George C. Whipple

SCIENTIFIC JOURNALS AND ARTICLES

The contents of the *American Journal of Science* for July are:

"Storm King Crossing of the Hudson River, by the New Catskill Aqueduct, of New York City," J. F. Kemp.

"Lake Parinacochas and the Composition of its Water," G. S. Jamieson and H. Bingham.

"Shell Heaps of Maine," F. B. Loomis and D. B. Young.

"Mixtures of Amorphous Sulphur and Selenium as Immersion Media for the Determination of High Refractive Indices with the Microscope," H. E. Merwin and E. S. Larsen.

"Asymmetry in the Distribution of Secondary Cathode Rays produced by X-rays; and its Dependence on the Penetrating Power of the Exciting Rays," C. D. Cooksey.

"Derivation of the Fundamental Relations of Electrodynamics from those of Electrostatics," L. Page.

"Hydrolysis of Esters of Substituted Aliphatic Acids," W. A. Drushell.

"Some Suggested New Physiographic Terms," DeL. D. Cairnes.

The following articles are printed in the *Journal of Genetics* for June:

"Species Hybrids of *Digitalis*," W. Neilson Jones.

"Notes on Inheritance of Color and other Characters in Pigeons," L. Doncaster.

"On Heterochromia Iridis in Man and Animals from the Genetic Point of View," C. J. Bond.

"Second Report on the Inheritance of Color in Pigeons, together with an Account of some Experiments on the Crossing of certain Races of Doves, with special reference to Sex-limited Inheritance," Richard Staples-Browne.

"Gigantism in *Primula sinensis*," Frederick Keeble.

RECENT WORK IN SYSTEMATIC AGROSTOLOGY

Beiträge zur Gramineenflora von Misiones: E. L. Ekman (*Arkiv f. Botanik,* 11: no. 4. 1912).

The author visited for three months in 1907–08, Misiones, that portion of Argentina lying between Uruguay and Paraguay. The above article is a critical account of the grasses collected at this time. The author enumerates 125 species and gives a table showing the relation of these to the surrounding regions. The larger genera are *Panicum* 27 species (23 species as the genus is limited by Hitchcock and Chase), *Paspalum* 19 species and *Andropogon* 14 species (including *Sorghum, Sorghastrum* and *Heteropogon*). There are four beautiful plates, taken from photographs, by the gelatin process, and illustrating the inflorescence, the details of which are excellently shown. The work inspires confidence from the incorporation of numerous critical notes. It is interesting to note that the anomalous *Leptochloa spicata* is transferred to the genus *Tripogon,* a disposition which is well supported by evidence. The descriptions of new species are in Latin, the notes in German.

The Grama Grasses: David Griffiths (*Contr. Nat. Herb.,* 14: 343–428, 1912).

This was reviewed recently by Dr. Bessey[1]

[1] Science, April 12, 1912, p. 590.

and here may be added only a few agrostological notes. The pen-and-ink drawings by Agnes Chase, illustrating the details of the spikelet, are accurate and particularly helpful in a group having so complicated a floral structure. The half-tones from photographs by the author illustrating the habit are unusually good. The genus *Cathestecum,* placed in the tribe Zoysiæ by Bentham & Hooker and in Festuceæ by Hackel (Engl. & Prantl, Pflanzenfam.) is here considered to be a close ally of *Bouteloua,* a conclusion well supported by the structure of the spikelets, as shown by the illustrations. The name *Bouteloua* is used rather than the older spelling *Botelua.* This suggests the desirability of adopting a definite rule to govern such cases. Lagasca deliberately adopted *Botelua* in 1805, using this spelling throughout his article, but in 1816 changed this to *Bouteloua,* which spelling has been used by all later authors. Lagasca states that the genus was named for the brothers Boutelou. I have used Lagasca's corrected spelling myself, but there is a tendency at present to subject even the spelling of generic and specific names to the law of priority. There are several changes in the names of familiar species. *Bouteloua procumbens* (Durand) Griffiths, for *B. prostrata* Lag.; *B. gracilis* (H. B. K.) Lag., for *B. oligostachya* Torr.; *B. barbata* Lag., for *B. polystachya* (Benth.) Torr.; *B. trinii* (Fourn.) Griffiths, for *B. trifida* Thurb. and *B. burkii* Scribn. On technical grounds, the name *Bouteloua bromoides* disappears altogether. In place of this we have *B. filiformis* (Fourn.) Griffiths, and two allied species, *B. radicosa* (Fourn.) Griffiths and *B. repens* (H. B. K.) Scribn. & Merr. Dr. Griffiths accepts 1881 as the date of publication of Fournier's work on "Mexican Grasses." The title-page date is 1886, but at least two copies of press-proofs were distributed in 1881 and used by Bentham and by Hackel as if published. By admitting the earlier date the author is obliged to take up *Chondrosium trinii* Fourn. which antedates both *Bouteloua trifida* Thurb. (1883) and *B. burkii* Scribn. (1883).

Plants of Southern New Jersey: WITMER STONE (*Ann. Rep. N. J. State Mus.,* 1910).

The title page date of issue is 1911, but the volume did not reach us until February, 1912. Reference will be made here only to the portion relating to the Gramineæ (pp. 174–246, pls. 5–15). As to form, the work is a model for its class. Though no descriptions are given, there are excellent keys to genera and to species. There are also important notes upon habit and local distribution. The half-tone plates illustrating the inflorescence are unusually good. In the recent revision of *Panicum* by Hitchcock and Chase many interesting northern extensions of the range of species to New Jersey are based upon Mr. Stone's collections, such as that of *P. wrightianum.* This species has since been collected on Cape Cod by E. W. Sinnott, and by Clarence Knowlton. I wish to criticize a method in technique adopted by the author. In this I do not wish to criticize Mr. Stone, because he has ample precedent for the method used. It is the citation of names in synonymy in such a manner that the reference appears to be the original publication when in reality it is to a later work or to a work in which the name has been misapplied. For example, "*Panicum sphagnicola* Nash, Brit. Man. Ed. I. 85." is given under *Panicum lucidum* Ashe. The original publication of *P. sphagnicola* was several years earlier (*Bull. Torrey Club,* 22: 422. 1895). The author means by his reference that *P. lucidum* was described under the name *P. sphagnicola* in Britton's Manual. Apparently Mr. Stone has intended to distinguish the original place of publication by giving the citation in full with date. But under *Tripsacum* we see as the second name in the list of synonyms, "*Tripsacum dactyloides* Nuttall Gen. I. 85. 1818," although the name was first published by Linnæus ("Syst. Nat.," ed. 10: 1261. 1759). This is not an error on Mr. Stone's part, as is shown by the accepted name at the heading where "L." is given as the authority. Mr. Stone probably inserted the Nuttall reference because of a note there on the local flora.

Erianthus alopecuroides "Gray Man. Ed. I. 616. 1848," appears as a synonym under *E. saccharoides,* though the original author of the former was Elliot in 1816. This method of citation lacks precision. On seeing the above citation one might justly infer that Gray's Manual is the original place of publication of *Erianthus alopecuroides.* This, however, is not the idea the author wished to convey. What he does mean is that in Gray's Manual the name *E. alopecuroides* Ell. was erroneously applied to *E. saccharoides.* Authors have recognized this lack of definiteness and have attempted in various ways to avoid it. Some would write the reference *E. alopecuroides* "Ell.," Gray Man. 616. 1848. Others, *E. alopecuroides* Ell. err. det. Gray (cf. Piper, "Flora of Washington," Contr. Nat. Herb., Vol. 11). I have used this, *E. alopecuroides* [Ell. misapplied by] Gray, Man. Some would place original references in one category and misapplications and secondary references in another, or make a statement in a note that Gray (Man. 616) described this species under *E. alopecuroides* Ell. I do not wish here to recommend especially any of the above methods, but only to insist on the necessity of distinguishing between the two categories of citations, publication and misapplication.

Mr. Stone has used for the citation of authors the method rather generally adopted by zoologists, in which only one author is given and that one the author of the specific name. The great majority of botanists cite at least the author of the accepted combination of genus and species, and often also the author of the specific name if published originally under a different genus. Under *Uniola* we find *Uniola laxa* (L.), showing that Linnæus gave the specific name *laxa* under a different genus. In the list of synonyms given by Mr. Stone we see that Linnæus described the species as *Holcus laxus.* In the list of synonyms also appears *Uniola laxa* Britton 294, but this is only a reference to localities given in Britton's "Catalogue of Plants of New Jersey" (I had some difficulty in determining the meaning of this reference), and not to the original publication of the combination (B. S. P. Prel. Cat. N. Y. 69. 1888). It happens that Mr. Stone has made certain combinations for the first time and hence will be cited by most botanical writers as the author of these combinations. But there is no means of determining which of the combinations are new, except by the laborious comparison of each case, since the combination may not appear in the list of synonyms, or if it does the reference may be misleading in this respect. Of course this omission is of no consequence to those who use the zoological method of citation. Mr. Stone probably did not realize the additional difficulties he was placing in the way of the indexer when he decided to omit all indications by which the new combinations could be distinguished. Among the grasses the following new combinations are made: *Paspalum læve circulare* (Nash) Stone, *Panicum commonsianum addisonii* (Nash) Stone, *Chætochloa imberbis versicolor* (Bicknell) Stone.

It is to be noted that Mr. Stone gives the original place of publication of *Panicum stipitatum* Nash, as Britton's Manual 83. The name was first used by Scribner (U. S. Dept. Agr. Div. Agrost. Bull. 17 (ed. 2): 56. May, 1901) where it is credited to "Nash, in Britt. Manual, 83, 1901." This must have been taken from proof sheets, as Britton's Manual did not appear till after August 24, 1901 (the date of the preface). This is mentioned only in reference to the question of the standing of proof sheets as publication.

As previously stated, these remarks are not intended as a criticism of Mr. Stone or of the excellent flora which he has published. The work suggested the remarks and this opportunity was taken to record certain protests.

Notes on Genera of Paniceæ: Agnes Chase (*Proc. Biol. Soc. Washington,* 19: 183–192, 21: 1–10, 21: 175–188, 24: 103–160).

It has long been recognized by agrostologists that the classification of the genera of grasses is still very artificial and greatly needs revision. Botanists who have turned their attention to this family have been kept busy with the classification of the species and very little has been done with the genera since the exposition by Bentham and Hooker (Gen. Pl. 3². 1883) and by Hackel (Engl. & Prantl, Pflanzenfam. 2². 1887). It is true that authors have attempted revisions of genera in local floras, recognizing the necessity of rearranging groups to accord with additional facts. But too often such rearrangement has been based solely upon species growing within the region covered by the flora. Nature knows no such limitations. Groups that are perfectly distinct in one area may in another area be connected by transition forms. Mrs. Chase has begun the revision of the genera of the entire family throughout the world. The four papers mentioned deal with the tribe Paniceæ, which will be completed in one more paper. The genera still to be discussed belong to the subdivision of the tribe in which the spikelets are surrounded by bristles. Under each genus is given a full discussion of the synonymy, a description of the genus as limited by the author, and, in American genera, an excellent text figure of the spikelet drawn from the type species. The author has been consistent in recognizing genera, basing validity upon characters of the same kind and degree. Such classification is necessarily the result of her botanical judgment, but this judgment is based upon a careful comparison of characters of the group as represented throughout the world, and unbiased by tradition or authority. Those who have given only superficial attention to grasses, and to whom certain names have become familiar, will "view with alarm" the splitting up of such genera as the heterogeneous *Panicum*. But a close study must convince the most conservative that the great genera *Panicum* (in the restricted sense) and *Paspalum*, recognized as distinct since their separation by Linnæus, are more closely allied than any of the segregates from *Panicum* recognized by Mrs. Chase, such as *Syntherisma* (*Digitaria*). In fact in the excellent synoptical key to genera, appearing in Part IV., *Valota* (*Panicum leucophæum*), *Syntherisma* and *Leptoloma* (*Panicum cognatum*) are numbered 3, 4 and 5, while *Panicum* and *Paspalum* are numbered 16 and 17. The author quite properly revises the nomenclature of the species in each genus in so far as this can be done without a further study of type specimens. Much just criticism has been directed against what some have been pleased to call "name-juggling," a sort of pop-gun revision, in which the primary purpose has been to change names or create new combinations. The nomenclature of a group of plants should be revised by the person who revises the taxonomy. And nomenclature in its applications should not be considered apart from the study of the plants involved. Mrs. Chase, however, has given the taxonomy careful study and is in position to adjust the nomenclature. It is hoped that the other tribes of grasses may be revised by her in the same manner.

North American Flora. Poaceæ: G. V. Nash (*N. A. Fl.* 17: 77–98. 1909).

In this number only a beginning is made, including a key to the thirteen tribes, and descriptions of the first 18 genera, up to and including *Elionurus*. The form of treatment is fixed by the general style of the work, for which reason certain criticisms must be shared by the editors. But the style adopted by the editors is the result of definite consideration and any criticism of this must take the form of a protest or regret. Probably the omission that the student will most often regret is the lack of cited specimens. To the student of grasses the mention of a few selected specimens might well take the place of the plates listed. It is also to be regretted that room could not be found for critical notes on synonymy. It is a good idea to give the type species of each genus, but there will be many cases where selection must be made and it would be helpful if the reasons for a certain choice were given. In *Hemarthria* the first of two species was chosen. In *Miscanthus* the second species is chosen. The reason for rejecting the first species is a good one, namely, because Andersson, the author of the genus, remarks that the first species, *M. capensis*, shows a transition to other genera, but it would be more satisfactory to the student if this reason were given. It will be interesting to note the manner in which Mr. Nash in the future parts of the work solves the various difficulties which will beset him in fixing the types of the genera.

The name *Tripsacum acutiflorum* Fourn. (*Bull. Soc. Bot. Belg.* 15: 466. 1876) is accepted in place of *T. lanceolatum* Rupr. (Fourn. Mex. Pl. 2: 68. 1881). This is based upon the statement made by Fournier, in a discussion of grasses with separated sexes, that in *Tripsacum* the peduncle of the male spikelet, ordinarily free, "est soudé avec le rachis de l'épi dans le *T. acutiflorum* n. sp." This statement certainly does not distinguish *T. lanceolatum* from the other species and can scarcely, therefore, be considered as sufficient to constitute publication. It is rather to be taken as incidental mention within the meaning of the American Code of Botanical Nomenclature (Canon 12. A name is not published by its citation in synonymy, or by incidental mention). The allies of *Rottbœllia cylindrica* have difficulty in keeping their names. When Otto Kuntze showed that the type species of *Manisuris* was a *Rottbœllia,* the names of these species were changed from *Rottbœllia* to *Manisuris.* Now Mr. Nash decides that this group is not congeneric with the type of *Manisuris,* but belongs to the genus *Stegosia* and the species are all transferred to the new allegiance. At the same time that Kuntze made the disconcerting discovery mentioned above he found it necessary to change the name of the grass generally called *Manisuris granularis,* since it obviously was not a true *Manisuris.* He called it *Hackelochloa granularis,* and is followed in this by Mr. Nash (and also by the present writer. See "Grasses of Cuba"). However, it appears necessary to take up for this genus the name *Rytilix* Raf. (*Bull. Bot. Seringe,* 1: 219. 1830).

While Mr. Nash's contribution is not, and could not be expected to be, monographic, it will be, when completed, of great service to agrostologists.

A. S. Hitchcock

SPECIAL ARTICLES

RHYTHMICAL ACTIVITY OF ISOLATED HEART MUSCLE CELLS IN VITRO

In previous communications[1,2] I pointed out that the heart muscle of chick embryos will beat rhythmically for many days when suspended in the media of a tissue culture and from such transplanted tissue there is an active growth of cells into the surrounding media. Braus[3] has repeated these experiments, using the hearts of embryo frogs and toads and he has found that these isolated beating hearts react to electrical and chemical stimuli similar to the intact heart. Braus also noted that the cells which grew from the hearts of cold-blooded animals were living at the end of three months. Very recently, Carrel[4] by the use of the method of repeated transplantation of the tissue from a culture to a fresh medium (Carrel and Burrows) has attempted to prolong the life and function of heart muscle *in vitro.* His experiments show that the rhythm which I noted in fragments of embryonic chick hearts can be prolonged, although intermittently, for a period of 85 days. The results of these experiments substantiate, therefore, the former well-known fact, namely, that strips of heart muscle, both of cold and warm blooded animals (Erlanger), will beat for some time when placed in the proper media. In none of these cases could one rule out, however, the possibility of the existence of nerve ganglia or some possible precursor in the young embryonic hearts, which might initiate rhythmical contractions.

During the present year experiments have been made to determine the conditions which would prolong the life and allow the development of functional activity in the cells which had grown and differentiated in the culture.

[1] Burrows, M. T., 1911, *Jour. Exp. Zool.*, Vol. 10, 63.

[2] Burrows, M. T., 1912, *Anat. Record*, Vol. 6, 141.

[3] Braus, H., 1912, *Weiner Med. Wochschr.*, No. 44.

[4] Carrel, A., 1912, *Jour. Exp. Med.*, Vol. XV., 516.

These experiments have shown that the newly grown, cellular syncytia and the isolated single heart muscle cell can become functionally active, beating with a rhythm similar to that of the intact heart.

Pieces of the hearts of chick-embryos of all ages and of young hatched chickens were used. A growth of tissue, composed almost entirely of muscle cells, occurred from all pieces when suspended in the media of both types of cultures, (1) the ordinary hanging drop culture (the plasma modification[1]) of the method of Harrison[5] and (2) a large modified type of culture. This apparatus is so arranged as to supply the tissues continuously with fresh media and to wash away the waste products without in any way disturbing the growing cells. I described this method in detail before the American Association of Anatomists, December 27, 1911.[2] Serum was used as the fluid medium in the latter type of culture.

Rhythmical activity of the newly grown cells was noted in 3 out of 15 of the large type of cultures (No. 2), and in 2 out of 150 of the ordinary hanging drop cultures. These cells were located definitely within the clot and had a clear cytoplasm which contained very few fat droplets. The rhythmical activity did not occur during the active outwandering of the cells but, later, after they became permanently located in a definite portion of the clot and were undergoing slow multiplication and differentiation. In one culture rhythm occurred as early as the fifth day, while in others as late as the fourteenth day of the life of the culture. The greater number of positive results in the large type of culture (No. 2) can be associated with the active and continuous growth of the tissue over a sufficient period of time. Active growth and a regular rhythm has been observed in these cultures for 30 days, while in the hanging drop culture the active growth and the regular rhythm cease after the third or fourth day. The growth then becomes gradually less and the rhythm intermittent, ceasing entirely after 10 or 18 days unless the tissue is transferred to a new medium. The method of repeated transplantation from the culture to a new medium has not as yet been sufficiently developed to allow any increase in the life and the activity of the newly grown cells. At each transfer of the tissue the actively growing and multiplying cells are destroyed and a new growth takes place from those more latently active cells in or about the tissue mass.

[5] Harrison, R. G., 1907, *Proc. Soc. Exp. Biol. and Med.*, 140; 1910, *Jour. Exp. Zool.*, Vol. 9, 787.

The original pieces of heart muscle transplanted to a tissue culture vary as to their rhythmical activity in relation to the portion of the heart from which they are taken as well as the age of the embryo. Pieces of the auricle, especially of that part situated near the entrance of the veins, taken from embryos of all ages and from young hatched chickens, beat when suspended in plasma. The pieces of the ventricle do not beat when taken from embryos older than 10 days, unless special methods of preparation and treatment are used.

Rhythmically beating cells have been grown from the contracting pieces of the hearts of young embryos and from one piece of the ventricle of a fourteen-day chick embryo. The absence of movement in the original mass of tissue of this culture facilitated greatly the study of the delicate contractions of the newly grown cells. The syncytial network which surrounded the original tissue and one isolated cell were beating rhythmically. This cell was situated far out in the clear medium away from all other tissues and beat with a rhythm independent in phase from that of the syncytium. The rate of all beating cells in this culture was the same, 50 to 120 per minute, or a rhythm typical for rhythmical beating pieces of ventricular muscle.

The experiments show: (1) that the cells which have grown and differentiated in a tissue culture can later assume their characteristic function; (2) that rhythmical contraction similar to that observed in the embryonic heart can occur in an isolated and single heart muscle cell; (3) that the rhythmically contracting cells can be grown not only from the pieces of hearts of young embryos, but from the heart muscle of a fourteen-day chick embryo.

These experiments, therefore, give direct evidence for the myogenic theory of the heart beat.

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ON MOLECULAR COHESION. A PRELIMINARY STATEMENT

There is much uncertainty both about the laws and nature of molecular cohesion. The attraction has been supposed to vary inversely with the square, the fourth, fifth, seventh, or even the ninth power of the distance between molecular centers; and whether cohesion is of the nature of magnetic, electric, or gravitational attraction, or whether it is of a kind of its own, is uncertain. Its relation to gravitation, on the one side, and to atomic affinity, on the other, is unknown.

1. *The Derivation of the Value a/V^2 in Van der Waals's Equation.*—The value of a/V^2 in Van der Waals's equation represents molecular cohesion. If each molecule has a mass of cohesion, M, and if the molecules attract each other inversely as the fourth power of the distance, as Sutherland suggests, then the attraction between two molecules is $M^2K/v^{4/3}$, v being the volume of one molecule. If there are $1/v^{2/3}$ molecules in a surface of one sq. cm. of a gas or liquid, the pressure per sq. cm. will be M^2K/v^2. If each molecule attracts only its neighbors, owing to the fact that the cohesion does not penetrate matter, then the internal pressure will be the same as the attraction of each double layer of molecules and instead of M^2K/v^2 we may multiply numerator and denominator by N^2, where N is the number of molecules in the volume V. This makes N^2M^2K/V^2, which is the value a/V^2 of Van der Waals's equation. It has the advantage over the usual form, a/V^2, in that the various constituents of "a" appear at once.

2. *The Latent Heat of Vaporization.*—Mills discovered the empirical relationship that the internal latent heat of vaporization divided by the difference of the cube roots of the densities of the liquid and vapor was a constant, except near the critical temperature. His equation was: $L - E_e = K(d^{1/3} - D^{1/3})$. He assumed that the internal latent heat of vaporization, or $L - E_e$, where L is the total latent heat and E_e that part of it consumed in doing external work, represented only the energy consumed in separating the molecules. He was struck by the resemblance of this equation, when transformed into $L - E_e = K'(1/v^{1/3} - 1/V^{1/3})$, to that of Helmholtz representing the heat given out from the sun on contraction from the radius CR to the radius R, or $3M^2K(1/R - 1/CR)/5$. The latter equation is derived by the gravitational law. Mills, therefore, concluded that the attraction of molecules must also follow the gravitational law and vary inversely as the square of the distance. The error in Mills's reasoning is the assumption that $L - E_e$ represents only the work of overcoming molecular cohesion. It represents not only this but also the heat consumed by the expansion of the molecules from their volume in the liquid to their volume in the vapor, for the molecules certainly expand on passing from the liquid to the vapor. If the heat thus consumed by molecular expansion is E_m, then since the difference in molecular cohesive energy in the vapor and liquid is $N^2M^2K(1/v - 1/V)$, $L - E_e = N^2M^2K(1/v - 1/V) - E_m$. Near the critical temperature E_m becomes nearly zero, and at the critical temperature this goes into the form $L - E_c = N^2M^2K(1/v - 1/V)$. Since the heat rendered latent by the expansion of the molecules increases as we go downward from the critical temperature, the value $L - E_e$ must become constantly greater than $N^2M^2K(1/v - 1/V)$, by the amount E_m. This is found to be the case. For example in methyl propionate $(L - E_e)/(d - D)$ has the following values in absolute units taking gram mol quantities:

Temperature	$(L - E)/(d - D)$	N^2M^2K/Wt
100°	3.417×10^{11}	
200°	3.030	

250°	2.598	
256°	2.396	
257°.4 (critical)		2.353×10^{11}

The fact that Mills's equation gives a constant is, then, rather evidence against the hypothesis that the attraction is inversely as the square of the distance, instead of in favor of that hypothesis. The real representation of the gain in molecular potential energy on passing from the liquid to the vapor is more probably, as Sutherland and others have shown, the expression $N^2M^2K/(1/v - 1/V)$, and not $K(1/v^{1/3} - V^{1/3})$. The former expression is in harmony with the conclusion that the attraction is inversely as the fourth power of the distance.

3. *The Radius of Action of the Molecules.*—The most recent calculations of the radius of action of molecules make it about 1.2 to 2×10^{-7} cm., or about two molecule diameters in the liquid state. As means of measurement have improved, the radius has shrunk. The distance between the centers of ether molecules in the liquid state at 20° is about 6×10^{-8} cm. Einstein and Sutherland have computed that the radius of action is proportional to, and very nearly equal to, the distance apart of the molecular centers. Kleeman has computed it as a little less than a molecular diameter. The only interpretation of Einstein's result is that the molecules attract only their immediate neighbors and hence, as Mills suggested, molecular cohesion does not penetrate matter. This makes it possible for the cohesion to vary inversely as the fourth power of the distance; since, if the cohesion penetrated matter like gravitation and the attraction was inversely as the fourth power, the cohesional mass is so enormously greater than the gravitational mass that the cohesional attractions of two masses would, when the masses were near, greatly surpass their gravitational attractions.

4. *Computation of the Cohesive Mass, M.*—Since the value "b" of Van der Waals's equation is not constant, but varies both with the volume and temperature, it is impossible to compute M^2K from the deviation from constancy of the pressure-volume product of a gas. M^2K may, however, be computed from the surface tension, as follows: S is the tension along a line one cm. in length and the depth of the surface film, or $fv^{1/3}$. Then $S/v^{1/3}$ is the surface tension per sq. cm. across the surface film, if the latter is one molecule deep, as it probably is at absolute zero, for which temperature the final computation is made. If this act through the space of a molecule, we have $Sv^{2/3}$, the molecular surface tension energy. According to Eötvös this is equal to $3.015 \times 10^{-16}(T_c - T - 6)$, using absolute units and the volume of one molecule, and assuming that the number of molecules in a c.c. of gas under standard conditions is 2.77×10^{19}. This value, $Sv^{2/3}$, must be a function of the difference in molecular cohesive energy in the liquid and vapor, or $M^2K/v - M^2K/V = fSv^{2/3}$. At low temperatures M^2K/V drops out and at absolute zero $M^2K/v_0 = fSv^{2/3} = 3.015 \times 10^{-16}(T_c - 6)f$. To find "$f$" I had recourse to Thomas Young's formula: $S = rK/3 = rM^2K/3v^2$; r being the radius of action and equal to $v^{1/3}$ at absolute zero. Maxwell and Lord Rayleigh have a different coefficient from Young's, *i. e.*, 3/20 instead of 1/3. I could not decide which of these was right, but Maxwell's gives a value for the internal pressure requiring an impossible value for "b," if substituted in Van der Waals's equation, so that Young's seems to be right, unless I have made an error somewhere. We have then $S = M^2K/3v^{5/3}$; and $Sv^{2/3} = M^2K/3v_0$. Therefore $M^2K = 9.045 \times 10^{-16}(T_c - 6)$. If this value for M^2K is substituted in Van der Waals's equation using the critical data for pentane, ether, isopentane and benzene, "b"$_c$ is found to have very nearly the uniform value in all of $V_c/2.07$. Van der Waals found, by computing "a" from the coefficient of compressibility, that b_c was $V_c/2.03$; so the two results agree very well. The value obtained from the surface tension is, therefore, tolerably correct. The value of M^2K has been computed for a large number of substances from the critical temperature, pressure and volume, and from the surface tension; and the results are throughout in close agreement.

Having thus found M^2K, the volume "b" of the molecules in the liquid and vapor of pentane at 180° was computed. In the vapor it was 140.3 c.c., and in the liquid 124.24 c.c. for gram molecular quantities. The volume of the molecules in the vapor is, therefore, certainly larger than in the liquid.

4. *The Nature of Cohesive Mass. Relation between Cohesion and Gravitation and the Number of Valences. A Method of Determining the Valence of Compounds.*—*The very interesting relationship has been discovered that the value M^2K, the factor proportional to the square of the cohesive mass of a molecule, is equal to the constant* 2.97×10^{-37} *multiplied into the two thirds power of the product of the molecular weight and the number of valences in the molecule.* This relationship holds in such a variety of substances that it seems universally true. It gives a valuable means of computing valences, when the critical data are known. Van der Waals's constant "a" can then be computed very exactly for non-associating substances when the valence is known by the formula: $a = 2.97 \times 10^{-37}(\text{Wt. Val.})^{2/3}N^2$. The value is given in absolute units. N is the number of molecules in the volume taken.

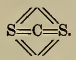
TABLE I

Substance	Mol. Wt.	Valences	$M^2K/(\text{Wt} \times \text{Val})^{2/3}$
Methyl formate ...	60	16	2.94×10^{-37}
Pentane	72	32	3.00
Iso-pentane	72	32	2.92
Ether	74	28	2.92
Benzene	78	30	2.93
Hexamethylene ...	84	36	2.92
Hexane	86	38	3.04
Ethyl acetate	88	28	2.95
Propyl acetate ...	102	34	2.97
Ethyl propionate .	102	34	2.95
Octane	114	50	3.14
Diisobutyl	114	50	2.98
Carbon tetrachloride	153.8	16	3.03
Stannum tetrachlor.	260.8	16	2.89
(Methyl alcohol ..	32	10	4.634)
Helium	4	1	2.90
Hydrogen	2	2	3.07
Oxygen	32	2	2.88
Argon	39.9	1	3.10

The short table illustrates the constancy of c, the quotient, when the factor M^2K, computed in the manner just mentioned from the surface tension, is divided by the two thirds power of the product of the molecular weight and the number of valences per molecule.

It will be seen from this table that the substances of which the valence is not doubtful, and of which the critical data have been so carefully determined by Young, give a constant value of c. Associating substances, like methyl alcohol, give a quotient higher than the average. A higher mean molecular weight and valence number must obviously be taken for these substances. The high figure for argon may indicate that at the temperature at which its density was determined, there was a slight association, a few two-atom molecules being present. If this is the case, 39.9 would be probably a mean molecular weight. If the theoretical value of 2.97 be supposed to be correct instead of 3.10, it would be necessary for the mean valence number to be 1.06; and from this the atomic weight of 37.5 instead of 39.9 would be computed. The critical data of krypton do not fall in line with the formula; and xenon, if the critical data are right, must be taken as bivalent. In all the argon group, the valence must be taken at least as unity. These substances can not be considered as having zero valence, as that would make the value of c infinite, unless the cohesive mass was zero also. But that this is not zero is shown by the fact that the gases can be liquefied. The critical temperature of helium was taken as 7° Abs. instead of 5° as given by Onnes, and 8° as suggested by Dewar. Hydrogen gives a constant close to 2.94, if Sarrau's critical data are taken, but not when those of Olszewski are used. Oxygen is taken with a valence of 2 instead of 4. Even with this assumption it is only by using the recent determinations of density made by Mathias and Onnes that a value near to 2.97 can be obtained. These matters will be discussed in the complete paper. It is possible that the coefficients for the computation of M^2K should be different in these simple gases.

One of the most interesting results is that all organic chlorine compounds, with one or two possible exceptions, have trivalent chlorine. The formulas of such compounds will need revision to take account of this fact. Methyl chloride, if free valences do not exist, would need to be written: $H_2C{=}ClH$, which would show at once why it dissociates so easily into hydrochloric acid and methylene. Fluorine is monovalent in fluorine compounds; the other halogens have not been computed. Sulfur is generally hexavalent, but in sulfur dioxide it is quadrivalent. It is hexavalent in carbon bisulphide. The formula might be:



The fact that chlorine is trivalent in its organic compounds confirms Drude's and Pascal's deductions from a study of the refractivity, normal dispersion, and molecular magnetic susceptibility of these compounds. Pascal found fluorine to be monovalent, chlorine to be polyvalent.

The fact that the cohesion is thus determined in part by the number of the valences, and that a relationship, long ago foretold by Laplace, is thus shown to exist between molecular cohesion and refraction and dispersion of light is of great interest. The formula $M^2K = c(\mathrm{Wt.\ Val})^{2/3}$ shows, on the electronic theory, that the electrons of the atoms and those of the valences differ, and that they can not be summed. Hence the cohesion is proportional to their product, not to their sum. This conception was the starting point of Drude's reasoning concerning the influence of valence on refraction and dispersion. The general result of the establishment of this relationship between valence and cohesion, between gravitational mass and cohesional mass, between cohesion and light refraction, and between cohesion and diamagnetic properties is, on the whole, to lend support to Sutherland's view that molecular cohesion is of a magnetic nature. The fourth power law may possibly bear this out, as he urged. The relation of intramolecular cohesion, or chemical affinity, and intermolecular cohesion is also seen to be a very close one; and the latter is apparently dependent upon the former.

ALBERT P. MATHEWS
UNIVERSITY OF CHICAGO,
May 18, 1912

SOCIETIES AND ACADEMIES

THE NEW YORK ACADEMY OF SCIENCES
SECTION OF BIOLOGY

AT the regular meeting of the Section of Biology, held at the College of the City of New York, March 11, 1912, Chairman Frederic A. Lucas presiding, the following papers were read:

The Number and Kinds of Bacteria in City Dust: C.-E. A. WINSLOW and I. S. KLIGLER.

The authors presented the results of the examination of about 170 samples of dust from streets, schools, houses and public buildings in New York. The total numbers of bacteria found varied from 150,000 per gram to 145,000,000, averaging from 3,000,000 to 5,000,000 from the indoor dusts and 49,000,000 from the street dust. Spores made up usually less than one tenth of the total. The count obtained at body temperature was about half that at room temperature, averaging from 2,000,000 to 3,000,000 per gram in the indoor dusts and 22,000,000 in the street dusts. *B. coli* was usually present; in the street dust an average of 51,000 per gram was found and in two samples over 100,000, while none showed less than 100. The indoor dust, on the other hand, showed an average of between 1,000 and 2,000. Acid-forming streptococci, such as are characteristic of the mouth, were present to the extent of over 1,000 per gram in three fourths of the street samples and one half of the indoor samples. The average for the street samples was about 40,000 per gram; for the indoor samples about 20,000 per gram. The large proportion of these organisms, particularly in the indoor dusts, appears to be significant of buccal pollution.

The Aerial Transmission of Disease: C. V. CHAPIN.

The diffusion of contagion through the room or out of doors only was considered, not droplet infection, which does not take place beyond a meter. Bacteriological evidence was not discussed, though the quantititative work of Winslow on sewer air and spray infection was referred to, a work which he is now extending to dust. Epidemiological study and experiment have been rapidly narrowing the list of alleged air-borne diseases. We now know that yellow fever and malaria are never air-borne. Experiments have shown that bubonic plague and Mediterranean fever are not. There is no evidence that cholera and typhoid fever are ever air-borne and much that they are not. The spread of influenza out-of-doors does not take place and perhaps not in-doors. The alleged evidence that smallpox virus is air-borne around hospitals is very weak. Careful observation in hospitals has shown that typhus fever, cerebro-spinal meningitis and poliomyelitis do not pass from patient to patient in the same ward. The same is true for uncomplicated scarlet fever and for diphtheria except by contact or close droplet infection. Probably measles and whooping cough, rubella, mumps, chickenpox and smallpox are not air-borne, even in the same room, but further observation may show that such infection may rarely take place.

At the regular monthly meeting of the section held at the American Museum of Natural History, April 8, 1912, the following papers were read:

Sex-linked Inheritance in Poultry: T. H. Morgan.

A summary of experiments carried out with the collaboration of H. D. Goodale: relating especially to the inheritance of the factor for barring in Plymouth Rocks and Dominiques crossed to Langshans. The paper is being published in the *Annals.*

The Spawning Habits of the Sea Lamprey, Petromyzon marinus: L. Hussakof.

An abstract of this communication was published in Science, March 22, 1912, pp. 460–461. The speaker exhibited a small model of the lamprey group now under construction in the American Museum.

Notes on Cuban Marine Fishes: John T. Nichols.

The speaker dealt with the results of a brief collecting trip to Cuba and exhibited various specimens. He passed in review some of the Scombriform fishes. The king fish, *Scomberomorus cavalla,* is highly esteemed, but another species, *S. regalis,* is said to be occasionally poisonous. *S. maculatus,* the Spanish mackerel, was not seen. While *regalis* and *maculatus* occupy more or less distinct areas, *cavalla* is abundant both in Florida, with *maculatus,* and in Cuba, with *regalis;* in the speaker's opinion these two last named species, which are still closely related, have recently become separated through the competition of *cavalla.* Two very widely separated forms, *Arbaciosa rupestris* and *Gobius soporator,* were found inhabiting adjacent rock pools; both were concealingly colored and could have been confused until their distinctive color patterns were noticed.

At the regular monthly meeting of the section held at the American Museum of Natural History, May 13, 1912, the following papers were read:

Note on the Habits of the Climbing Cat-fish (Arges marmoratus) from the United States of Colombia: R. D. O. Johnson.

Although living in streams of high grade and torrential force these fish were enabled not only to hold their place against the current, but even to advance up-stream and to climb out of a steep-walled, deep pot-hole. They did this by means of curious sucker-like adaptations of the mouth and ventral fins. The paper will appear in the *Annals.*

On the Changes in Behavior of the Eel (Conger malabaricus?) during its Transformation: Bashford Dean.

When at Misaki, Japan, the speaker had made observations upon the structure and behavior of a living leptocephalus larva which was kept alive in an aquarium for over three weeks, during this time undergoing its metamorphosis. Especially interesting is the rapidity with which the behavior of the young eel changes from day to day in its methods of swimming and resting, response to stimuli, etc. The speaker suggested that these marked differences in behavior in successive stages were correlated with kaleidoscopic changes in elements of the central nervous system; that when more fully known this would probably afford a suggestive case of parallelism between psychic reactions and neurological conditions. The paper will appear in the *Annals.*

Notes on Certain Principles of Quadrupedal Locomotion and on the Mechanism of the Limbs of Hoofed Animals: William K. Gregory.

The speaker gave a brief résumé of a paper that is being published in the *Annals.*

On the Dictyonema Fauna of Navy Island, New Brunswick: F. F. Hahn.

Read by title. To be published in the *Annals.*

The secretary gave an abstract of a communication from Dr. P. Bachmetjew, of Sofia, relating to the physiology of *Vesperugo pipistrellus* and *Miniopterus schreibersii.* In some cases these bats had been thawed out and the heart action had resumed even after the body had been cooled to — 7° Cent. below the body temperature.

The section adjourned until October 14, 1912.

William K. Gregory,
Secretary

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SCIENCE

FRIDAY, JULY 26, 1912

CONTENTS

MSS. intended for publication and books, etc., intended for review should be sent to the Editor of SCIENCE, Garrison-on-Hudson, N. Y.

SIR WILLIAM HERSCHEL[1]

DURING the last twenty years there has been a great revival of statistical investigations as to the distribution and motions of the so-called fixed stars. Kapteyn, of Groningen, is the leader of those who are renewing the attempt to obtain in this way some idea as to the construction of the universe. Earlier astronomers had of course done something in this direction, but the work of William Herschel so far transcends that of all others, that it would be fair to describe him as the originator of this class of investigation. It may be of interest to mention that a complete edition of his works is now in course of publication, under the direction of a joint committee of the Royal and Astronomical Societies.

The interest of Herschel's writings, and the simple charm of his style—written it is to be remembered in a language which was not his from birth—have led me on to read about the man as well as about his scientific work. Throughout his life's work his name is inseparable from that of his sister Caroline, and I hope it may prove of interest to you to hear of what they were as well as of what they did. They were born at Hanover, he in 1738, she in 1750, the children of a bandsman of the Hanoverian Guards. At the age of fifteen Herschel was already a member of the Guards' band. In 1757 the regiment, which had been in England for about a year, served in Germany during the Seven Years' War, and William seems to have suffered from the hardships of the cam-

[1] An address before the Royal Institution of Great Britain, given on April 26, 1912.

paign. His parents, seeing that he had not the strength for a soldier's life, determined to remove him from the regiment. The removal may be described more bluntly as desertion, for we learn that when he had passed the last sentinel at Herrenhausen, he took off his uniform and his luggage was secretly sent after him to Hamburg. At any rate, fortunately for science, he escaped, and in 1757 or 1758 made his way to England.

It would perhaps be impossible to follow him throughout his wanderings, but we know that he was at one time instructor of the band of the Durham Militia, and afterwards that he gained his living as a musician in Leeds, Halifax, Pontefract and Doncaster. In 1764 he even ventured back to Hanover for a short time, and thus saw his favorite sister again.

During her early years Caroline seems to have been practically the household drudge or general servant, and whatever she learned was by stealth or in the scanty intervals snatched from her household duties, for her mother thoroughly disapproved of education for a girl.

When we reflect on the difficulties under which both brother and sister labored, and then consider how much they were able to accomplish, we might be tempted to underrate the value of educational advantages. Concerning education, Bishop Creighton once said in my hearing, "It is surprising how little harm we do notwithstanding all the pains we take." Paraphrasing the remark, although spoiling the epigram, I would say, "It is surprising how little harm the lack of opportunity does to a great genius."

In 1766 William took a position as organist at Bath, then at the height of fashion. The orchestra at the Pump Rooms and at the theatre at Bath was then one of the best in the kingdom, and Elizabeth Linley, daughter of the director of the orchestra, was the prima donna of the concerts. When in 1771 she became engaged to Charles Sheridan, Herschel thought that the expected vacancy would make an opening for his sister at Bath, and suggested that she should join him. And, in fact, after a time such a vacancy did occur, for Elizabeth Linley, after flirting with Charles Sheridan, jilted him and eloped with and married the celebrated Richard Brinsley Sheridan.

Caroline was very anxious to accede to her brother's suggestion, but the rest of the family would not for a time hear of it. At length, however, in 1772, Herschel came to Hanover and carried off his sister with the mother's reluctant consent. Even from boyhood his intense love of astronomy had been manifest, and it is interesting to note that in passing through London on their way from Harwich to Bath, when they went out to see the town, the only sights which attracted their attention were the opticians' shops.

On Mr. Linley's retirement from the orchestra at Bath, Herschel became the director and the leading music-master in the town, and he thus obtained an established position. Although Caroline sang a little in public, her aspiration to become the prima donna of Bath was not fulfilled. But she was kept busy enough at first in the cares of housekeeping, with endless wrangling with a succession of incompetent slaveys, and then she gradually became more and more her brother's astronomical assistant.

In the midst of Herschel's busy musical life he devoted every spare moment to astronomy, and when his negotiations for the purchase of a small reflecting telescope failed—and they were all small in those days—he set to work to make mirrors for himself.

One room in the house was kept tidy for pupils, and the rest of the house, including the bedrooms, was a litter of lathes and polishing apparatus. He made reflecting telescopes not only for his own use, but also for sale, for the purpose of providing funds to enable him to continue his researches. His industry must have been superhuman, for later in his life he records that he had made over 400 mirrors for Newtonian telescopes, besides others of the Gregorian type. These mirrors ranged in diameter from a few inches to 4 feet, in the case of the great 40-foot telescope. I should say that mirrors are not specified by the diameter of the reflecting surface, but by the focal length. Thus, whatever may be the diameter of the reflecting surface, a 20-foot telescope means that the mirror is approximately portion of a sphere of 40 feet in radius, and this will give a focal length of 20 feet. You must, in fact, double the focal length of a telescope to find the radius of the sphere of which it forms a small part.

In order to learn anything of the making of reflectors it is necessary to go to original memoirs[2] on the subject, and even of them there are not many. I feel, therefore, that I shall not be speaking on a topic known to many of the audience if I make a digression on a singularly fascinating art. Mirrors are now made of glass with a reflecting surface of chemically deposited silver; formerly they were made of speculum metal, an alloy of copper and tin. Of whatever substance the mirror is made the process of working it to the required form is much the same. The most complete account of the process of which I know is contained in a paper by Professor G. W. Ritchey in Vol. 34 (1904) of the Smithsonian Contributions to Knowledge. He there gives a full description of the great reflector of the Yerkes Observatory. The process only differs from that employed by Herschel in that he worked by hand, whereas machinery is now required to manipulate the heavy weight of the tools. The Yerkes mirror is formed of a glass disk 5 feet in diameter, and it weighs a ton; the grinding tools are also very heavy.

I must pass over the preliminary operations whereby the rough disk of St. Gobain glass was reduced to a true cylindrical form, smooth on both faces and round at the edge. Nor will I describe the grinding of a shallow depression on one of the faces by means of a leaden tool and coarse emery powder.

It will be well to begin by an account of the manufacture of the tools wherewith the finer grinding and polishing is effected, and then I shall pass on to a short description of the way they are used.

Two blocks of iron are cast with the desired radius of curvature, the one being concave and the other convex. The castings are then turned so that the concavity and convexity fit together as nearly as may be. For the large mirror these blocks are a little over 2 feet 6 inches in diameter, but for small ones they are made of the same diameter as the mirror to be ground. The two are then ground together for a long time with emery powder and water until every part of one surface fits truly to every part of the other. They must then both be portions of a sphere of the same radius, because the sphere is the only surface in which a universal fit is possible. The concave iron is very precious because it furnishes the standard for regrinding the convex grinding tools when they have become worn by use. In order to make a plane mirror, three surfaces are ground

[2] Sir Howard Grubb's lecture at the Royal Institution in 1887 is one of these, Vol. XI., p. 413. Lord Rosse's papers are amongst the most important.

two and two, for if A fits B and C, and B fits C all over each surface they must all be true planes. However, I shall only speak of the figuring of concave mirrors.

The roughly hollowed glass disk is now laid on several layers of Brussels carpet centrally on a massive horizontal turn-table. The convex iron tool just described is suspended by a universal joint from a lever, and it is counterpoised so that only a portion of the weight of the tool will rest on the glass when it is in use. A complicated system of cranks and levers is so arranged that the tool can be driven by machinery to describe loops or curves of any arbitrarily chosen size over the glass, and as these loops are described by the tool the turn-table turns round slowly. In this way every part of the tool is brought into contact with every part of the glass disk in a systematic way. When working near the edge a large part of the tool projects beyond the edge of the glass.

Emery powder and water are supplied in a way I need not describe, and the tool is lowered gently on to the glass. The motive power is then applied, and the grinding is continued for many hours until the preliminary rough depression has been hollowed to nearly the desired shape—namely, that of the standard concave iron.

For finer grinding a change of procedure is now adopted, and very finely powdered emery is used. Another convex tool is formed, by grinding with the standard concavity; the working face of the tool is, however, now cut up into small squares by a criss-cross of narrow and shallow channels. Such channels are found to be necessary in order to secure an even distribution of the emery and water all over the surface. The grooved tool is now used for many hours, and the surface is tested at frequent intervals with a spherometer. The work ceases when it is no longer possible to detect errors of curvature in this way.

The next stage is polishing. The thickness of the layer of glass worn off in polishing is to be estimated in ten-thousandths of an inch, and can scarcely be detected even with the finest spherometer. For polishing the iron tool is discarded and the work is carried on by hand. As lightness is essential, the tool is built up by a stiff lattice-work of wood with a continuous wooden working face. It is obvious that however carefully the face may be turned it can not be made sufficiently true, and the requisite accuracy is obtained by means of the plastic properties of rosin or pitch. A number of squares of rosin about a quarter of an inch thick and an inch square are made, and these are glued in rows on the convex face of the wooden tool, with a narrow space intervening between each rosin square and its neighbors. The tool is then warmed slightly so as to soften the rosin a little, and it is then pressed lightly on to the glass disk. By means of this "warm-pressing" a nearly perfect fit is attained.

Each of the rosin squares is then painted with hot melted wax. This is done because wax is harder than rosin and affords a better working face. Finally, when the tool is quite cold, the surface of the glass is painted all over with very finely powdered rouge and water, and the tool is placed gently on the glass with some additional weight resting on it. It is left thus for several hours, but is moved slightly every ten minutes to ensure an even distribution of the rouge and water. By means of this "cold-pressing" a perfect fit is secured of the wax-coated rosin squares with the glass face. Cold-pressing has to be repeated every day before the work begins.

The polishing is now carried on in much the same way as the grinding, but by hand instead of by machine power. The turn-table can be made to tilt so as to bring the glass to stand vertically, instead of horizontally, and the disk is frequently tilted up so as to submit the surface to optical tests. These latter tests are far more searching than those with a spherometer, and enable the observer to detect an error in the radius of curvature of portion of the reflector of a hundredth of an inch. To correct such an error it will be necessary to remove a layer of glass of $1/_{500000}$ths of an inch!

The most refined optical test is by the observation of the image of a brilliant light issuing from a pin-hole close to the intended center of the spherical surface. The observer examines the image of the pin-hole with a microscopic eye-piece placed as close as possible to the pin-hole. He then causes a straight-edge close in front of the eye-piece to move slowly across the reflected beam of light, either from left to right or from right to left, so as to eclipse the light. Previously to the eclipse the whole of the glass seems to be a uniform blaze of light, and if the curvature is perfect the light which enters the observer's eye comes from all parts of the disk, and the surface is seen to darken equably all over. But if the surface is imperfect the light from some part is eclipsed sooner than that from others, and the disk seems to possess considerable hills and valleys illuminated, as it were, by a setting sun.

The interpretation of these apparent hills and valleys shows where further local polishing with a small tool is requisite. Sir Howard Grubb says that if he suspects a hollow, he holds his hand near the surface for a minute or two; if a hill is suspected, he washes the region with an evaporating wash. The warmth in the one case and the cooling in the other tend to rectify, and indeed over-rectify, the errors.

When success is finally attained, after all we have only a spherical surface, and it becomes necessary to obtain a parabolic form. This last stage is done by further tests of the kind described, with a diaphragm placed over the mirror which only permits the observer to see the light reflected from chosen zones of the mirror. The time at my disposal will not allow me to describe this in further detail, or to tell you how there is always found to be one definite diameter of the glass along which its weight must be supported. I must pass by, too, the system of counterpoised levels used for supporting the back of the glass, and the method by which silver is chemically deposited on its surface. Meager although this sketch has been, it will have served to show you how beautiful are the processes employed, and I would ask you to realize that at first Herschel was a mere amateur, and had to discover everything for himself.

As I have said, Hershel had to do all his polishing by hand, and he found when once the final stage had begun, it was necessary that it should never stop even for a moment. Caroline relates how she was kept busy in attending on her brother when polishing:

> Since by way of keeping him alive I was constantly obliged to feed him by putting the victuals by bits into his mouth. This was once the case, when in order to finish a 7-ft. mirror, he had not taken his hand from it for sixteen hours together.

The making of the mirror is, however, but a small part of the difficulty of making a telescope, for it involves high engineering skill to provide a solid stand, an observing platform, the graduated circles in right ascension and declination for setting the telescope and the clock, whereby it is made to follow the stars in their daily motion. The great size of Herschel's mirrors and the weight of the long tube introduced mechanical difficulties which were at that time entirely new.

A dozen years after his establishment at Bath, Herschel began to be well known in the world of science, and many of the most illustrious astronomers came to see him. In 1781 he was elected to the Royal Society, and in the same year he discovered the planet Uranus, and called it by the now almost forgotten name of Georgium Sidus, in honor of George III. The magnitude of the discovery may be estimated by the fact that only the five principal planets, familiar to all men for centuries, were then known; and the asteroids or minor planets had not yet been discovered by Herschel himself. His fame from this and his other discoveries led to a command from the King to take his 7-foot telescope to Windsor, and there he was requested to act as celestial showman to the King, the Queen, and the Princess. The expedition put him to much expense, and he was kept hanging about Windsor for months, but at length the King offered him the post of private royal astronomer, with the modest salary of £200 a year.

Herschel's friend, Sir William Watson, said that never had a monarch bought honor so cheap, and Caroline pours scorn on the king's meanness; but I think this was hardly fair. It must have been well known that Herschel had deserted from the Hanoverian Guards, and while the King might consent to forget this, it was a strong measure to take the deserter into his service. At a later date, moreover, when the King was informed by Sir Joseph Banks of Herschel's financial difficulties, he granted him £2,000, afterwards increased to £4,000, for the construction of the great 40-ft. telescope, with the condition that he should retain it for his own use. To this was added a further £200 a year for maintenance, and a pension of £50 a year to Caroline Herschel. And besides he was allowed to make specula for sale, and half the observatories of Europe were so furnished by him at prices which were then thought considerable.

At any rate Herschel jumped at the offer, which, by relieving him from his musical slavery, allowed him to follow the wish of his life. The Herschels then came to the neighborhood of Windsor, and after several removals they finally settled at Slough. The change was delightful for him, since he now had space for his telescopes and workshops, but the difficulties of housekeeping in a rambling and dilapidated house rendered the change somewhat less agreeable to his sister.

The closeness to Windsor was perhaps a necessity of the case, but it had its disadvantages, since he was frequently summoned to take his telescope to Windsor, or large parties from the castle would visit him at his house in order to see the wonders of the heavens. When his time had been wasted in this way he would make up for the loss by redoubled labor.

The fury, as I may call it, with which they worked may be gathered from Caroline's journal, and the work was not free from danger, because in his eagerness Herschel would not always delay his observations until the telescope was properly fixed. To stand in the dark on a platform without a railing, when your attention is distracted from your position, can not be very safe, and they both met with a good many accidents which might easily have proved fatal.

The incessant work, together with the interruptions by the visitors from the castle, began at length to tell on Herschel's health. His sister notes that on the 14th of October, 1806, after working all day, he was out from sunset till past midnight surrounded by fifty or sixty persons, without food or proper clothing, and that he never seemed to recover completely from this great strain on his strength.

But I have passed by an event of importance in the lives of both brother and sister, for in 1783 he married Mrs. Pitt, a lady of singularly amiable and gentle character. To the sister, however, the marriage was a great blow, for, although she continued to be his secretary and assistant, she moved into neighboring lodgings, and was no longer so closely associated with him as theretofore. Mrs. John Herschel writes: "It is not to be supposed that a nature so strong and a heart so affectionate should accept the new state of things without much and bitter suffering," and tradition confirms this belief. All her notes and memoranda relating to a period of fifteen years from the time of the marriage were destroyed by her when, as we may presume, her calmer judgment showed her that the record of her heart-burning would be painful to the surviving members of the family. At any rate, she was on affectionate terms with her sister-in-law throughout all the later years of her life, and the brilliant career of her nephew, the celebrated Sir John Herschel, and correspondence with him, afforded the leading interest of her old age.

Although Herschel lived until 1822, and accomplished an enormous amount of work up to the end of his life, yet his health seems to have declined from about the time I have noted. On his death Caroline felt that her life, too, was practically ended and she returned to Hanover. Ever afterwards she used to cry, "Why did I leave happy England?" and it is incomprehensible that she should not have returned to the place where all her real interests lay.

Although she felt the death of her brother as practically the end of her life, she was always full of jokes and fun. In a letter to her nephew, she told him that her father used to punish her, a grown woman, by depriving her of her pudding if she did not guess rightly the angle of the piece she had helped herself to. Dr. Groskopf writes of her when she was eighty-nine years of age:

> Well! what do you say of such a person being able to put her foot behind her back and scratch her ear with it, in imitation of a dog, when she was in one of her merry moods?

She only died in 1847, having very nearly completed her ninety-eighth year.

Herschel himself must have been a man of singular charm, as is testified to by Dr. Burney and his daughter Mme. d'Arblay. That he possessed an incredible amount of patience is proved by the fact of his submitting to the reading aloud of the whole of a portentous, and fortunately unpublished, poem in many cantos by Dr. Burney, entitled "A Poetical History of Astronomy." It appears that Herschel had had an interview with Napoleon in Paris in 1802, and the poet Campbell asked him whether he had been struck by Napoleon's knowledge. Said Herschel:

> No, the First Consul surprised me by his versatility, but in science he seemed to know little more than any well-educated gentleman, and of astronomy much less, for example, than our king. His general air was something like affecting to know more than he did know.

He was struck, too, by Napoleon's hypocrisy in observing "how all these glorious views gave proofs of Almighty Wisdom."

And now having endeavored to show what kind of people Caroline and her brother were, I must turn to what they did. Herschel's discoveries were so numerous that I am compelled to make a selection. I shall therefore only attempt to sketch his endeavor to understand the general construction of the stellar universe, and to speak of his work on double stars.

The only general test of the relative nearness or farness of the stars is their brightness, because the faint stars must, on the average, be more distant than the bright ones. Herschel then proposed to penetrate into space by means of a celestial census of the distribution and of the brightness of the stars. With this object he carried out four complete reviews of the heavens, as far as they may be seen from our latitude, passing successively to the fainter and fainter objects by means of the increased size of his telescope.

He divided the heavens into sweeps 2° 15′ of breadth in declination, and each zone was examined throughout by the process which he called star-gauging. His census was made with the 20-ft. reflector, with which instrument the field of view was about one quarter of the size of the full moon. It needs over 300,000 of such fields of view to cover the whole of the hemisphere of space, and Herschel surveyed the whole northern hemisphere, and as much of the southern one as he could.

Von Magellan in a letter to Bode describes the method of observation as follows:

> He has his 20-ft. Newtonian telescope in the open air. . . . It is moved by an assistant who stands below it . . . near the instrument is a clock . . . in the room near it sits Herschel's sister, and she has Flamsteed's Atlas open before her. As he gives her the word, she writes down the declination and right ascension. . . . In this way Herschel examines the whole sky . . . he is sure that after four or five years (from 1788) he will have passed in review every object above our horizon. . . . Each sweep covers 2° 15′ in declination, and he lets each star pass at least three times through the field of the telescope, so that it is impossible that anything can escape him. . . . Herschel observes the whole night through . . . for some years he has observed . . . every hour when the weather is clear, and this always in the open air.

Herschel points out that by this survey he was not only looking into the most distant space, but also into the remotest past, for the light of many of the stars must have started on its journey towards us thousands or even millions of years ago. The celestial museum therefore exhibits to us the remotest past alongside with the present, and we have in this way the means of reconstructing to some extent the processes of evolution in the heavens. In photography the modern astronomer possesses an enormous advantage, but Herschel laid the foundation of this branch of astronomy without it.

The most conspicuous and the most wonderful object in the heavens is the Milky Way. It runs all round the skies in a great band, with a conspicuous rent in it forming a streamer which runs through many degrees. To the naked eye it shines with a milky light, but Herschel was able to show that it consists of countless stars in which there lie embedded many fleecy nebulæ. There is good reason to believe that the Milky Way on the whole consists of stars which are younger than those in the other parts of space, for the stars in it are whiter and hotter, and the nebulæ are mostly fleecy clouds. On the other hand, the spiral and planetary nebulæ are more frequent away from the Milky Way, and these are presumably older than the cloudy and flocculent nebulæ. The shape of the Milky Way seems to resemble a huge millstone or disk of stars, and since it forms a complete circuit in the heavens the sun must lie somewhere towards its middle. It is probable that we look much further out into space along this tract than elsewhere, although it happens that by far the nearest of all the stars—namely, α Centauri—lies in the line of the Milky Way.

This great congregation of stars is far from uniform in density, for there are places in it where there are but few stars or none at all. Caroline Herschel, writing to Sir John Herschel at the Cape of Good Hope, in 1833, mentions that her brother, when examining the constellation of the Scorpion (which lies at best low down on our horizon), had exclaimed, "after a long, awful silence, 'Hier ist wahrhaftig ein Loch im Himmel.'" And her nephew, as he said, rummaged Scorpio with the telescope and found many blank spaces without the smallest star.

It will explain some of the deductions which Herschel drew from his star-gauges, and will at the same time furnish a good example of his style, if I read a passage from a paper of his written in 1789.[3] He points out that the sun is merely a star, and, referring to the stars, he continues thus:

These suns, every one of which is probably of as much consequence to a system of planets, satellites and comets, as our own sun, are now to be considered in their turn, as the minute parts of a proportionally greater whole. I need not repeat that by my analysis it appears that the heavens consist of regions where suns are gathered into separate systems, and that the catalogues I have given comprehend a list of such systems; but may we not hope that our knowledge will not stop short at the bare enumeration of phenomena capable of giving us so much instruction? Why should we be less inquisitive than the natural philosopher, who sometimes, even from an inconsiderable number of specimens of a plant, or an animal, is enabled to present us with the history of its rise, progress and decay? Let us then compare together, and class some of these numerous sidereal groups, that we may trace the operations of natural causes so far as we can perceive their agency. The most simple form, in which we can view a sidereal system, is that of being globular. This also, very favorably to our design, is that which has presented itself most frequently, and of which I have given the greatest collection.

But, first of all, it will be necessary to explain what is our idea of a cluster of stars, and by what means we have obtained it. For an instance I shall take the phenomenon which presents itself in many clusters. It is that of a number of lucid spots, of equal luster, scattered over a circular space, in such a manner as to appear gradually more compressed towards the middle, and which compression, in the clusters to which I allude, is generally carried so far, as, by imperceptible degrees, to end in a luminous center of an irresolvable blaze of light. To solve this appearance it may be conjectured that stars of any given very unequal magnitudes may easily be so arranged, in scattered, much extended, irregular rows, as to produce the above described picture; or, that stars, scattered about almost promiscuously within the frustum of a given cone, may be assigned of such properly diversified magnitudes as also to form the same picture. But who, that is acquainted with the doctrine of chances, can seriously maintain such improbable conjectures?

[3] *Phil. Trans.*, Vol. LXXIX., p. 212.

Later in the same paper he continues:

Since then almost all the nebulæ and clusters of stars I have seen, the number of which is not less than three and twenty hundred, are more condensed and brighter in the middle; and since, from every form, it is now equally apparent that the central accumulation or brightness must be the result of central powers, we may venture to affirm that this theory is no longer an unfounded hypothesis, but is fully established on grounds which can not be overturned.

Let us endeavor to make some use of this important view of the constructing cause, which can thus model sidereal systems. Perhaps, by placing before us the very extensive and varied collection of clusters and nebulæ furnished by my catalogues, we may be able to trace the progress of its operation in the great laboratory of the universe.

If these clusters and nebulæ were all of the same shape, and had the same gradual condensation, we should make but little progress in this enquiry; but as we find so great a variety in their appearances, we shall be much sooner at a loss how to account for such various phenomena, than be in want of materials upon which to exercise our inquisitive endeavors.

. . . .

Let us, then, continue to turn our view to the power which is molding the different assortments of stars into spherical clusters. Any force, that acts uninterruptedly, must produce effects proportional to the time of its action. Now, as it has been shown that the spherical figure of a cluster of stars is owing to central powers, it follows that those clusters which, *ceteris paribus*, are the most complete in this figure, must have been the longest exposed to the action of these causes. This will admit of various points of view. Suppose, for instance, that 5,000 stars had been once in a certain scattered situation, and that other 5,000 equal stars had been in the same situation, then that of the two clusters which had been longest exposed to the action of the modelling power, we suppose would be most condensed, and more advanced to the maturity of its figure. An obvious consequence that may be drawn from this consideration is that we are enabled to judge of the relative age, maturity or climax of a sidereal system, from the disposition of its component parts; and, making the degrees of brightness in nebulæ stand for the different accumulation of stars in clusters, the same conclusions will extend equally to them all. But we are not to conclude from what has been said that every spherical cluster is of an equal standing in regard to absolute duration, since one that is composed of a thousand stars only must certainly arrive to the perfection of its form sooner than another which takes in a range of a million. Youth and age are comparative expressions; and an oak of a certain age may be called very young, while a contemporary shrub is already on the verge of its decay. The method of judging with some assurance of the condition of any sidereal system may perhaps not improperly be drawn from the standard laid down earlier; so that, for instance, a cluster or nebula which is very gradually more compressed and bright towards the middle may be in the perfection of its growth, when another which approaches to the condition pointed out by a more equal compression, such as the nebulæ I have called *Planetary* seem to present us with, may be looked upon as very aged, and drawing on towards a period of change, or dissolution. This has been before surmised, when in a former paper I considered the uncommon degree of compression that must prevail in a nebula to give it a planetary aspect; but the argument which is now drawn from the powers that have collected the formerly scattered stars to the form we find they have assumed, must greatly corroborate that sentiment.

This method of viewing the heavens seems to throw them into a new kind of light. They now are seen to resemble a luxuriant garden, which contains the greatest variety of productions, in different flourishing beds; and one advantage we may at least reap from it is, that we can, as it were, extend the range of our experience to an immense duration. For, to continue the simile I have borrowed from the vegetable kingdom, is it not almost the same thing, whether we live successively to witness the germination, blooming, foliage, fecundity, fading, withering and corruption of a plant, or whether a vast number of specimens, selected from every stage through which the plant passes in the course of its existence, be brought at once to our view?

I now turn to another line of discovery of which I can not show any pictures, but which, to me at any rate, is more interesting. Until 1838—that is to say, until sixteen years after Herschel's death—no one had succeeded in determining the distance of a single fixed star, but in that year Henderson and Bessel almost simultaneously attained success in the cases of the two stars α Centauri and 61 Cygni. The attempts at this measurement had already been numerous, and Herschel amongst others had failed, but his failure was a glorious one, for he made incidentally a discovery of another kind and of at least equal interest.

The earth moves around the sun at a distance of 93 million miles, so that in six months we shift our position by 186 million miles. If, then, there are two stars of which one is relatively near to and the other far from the sun, but so situated as to appear to us very close together, the near one ought to shift its position relatively to the distant one in the course of each six months. The amount of this change of position, called by astronomers annual parallax, should furnish the distance of the nearer of the pair, provided that the other is very far off. This idea is as old as the time of Galileo, but no one had been able to make successful use of it.

As I have already said, the only general test of the distance of a star is its brightness, and therefore Herschel chose pairs of stars of very different brilliancy. He thought, at least at first, that it was mere chance which brought the stars so near to one another, and there are undoubtedly such pairs now known as "optically double stars." But Herschel's mode of attack was bound to fail if the seemingly neighboring stars were really so, and were linked together by their mutual gravitation. Already as early as 1707 Michel had suggested the existence of such true double stars, but it was Herschel who proved their existence. His first catalogues of double stars, published in 1782, contained 203 cases of such doublets, and he already suspected a community in their motions explicable only by their real association; but by 1802 he had become certain. In many cases the two components of a binary pair were found to be moving in nearly the same direction and at the same speed, but superposed on this motion of the system as a whole there was an orbital motion of one star round the other. Herschel even lived long enough to see some of his pairs of stars perform half a revolution about one another.

After his death Savary took the matter one stage further, and showed that the revolution was governed by the laws of gravity, and thereby confirmed the truth of Herschel's belief. Thus the failure to measure the distance of stars led to the proof that gravity reigns amongst the stars as in the solar system.

Arago thought that of all Herschel's discoveries this was the one that had the greatest future, and his prophecy has proved singularly correct. Every year adds to the number of double stars, whose orbits are now accurately determinable. These systems are found to be very unlike our own solar system, for the component stars are, in many cases, far larger than the sun and revolve about one another in periods which, in various cases, may be either many years or only a few hours.

The spectroscope has, moreover, added enormously to our knowledge, for the speed of approach or recession of a star from the sun can now be determined as so many kilometers per second. Thus that component of the motion of a star which was concealed from Herschel is now known with the greater certainty. Moreover, being ignorant of the distance of the stars, he could only express the transverse component of motion in seconds of arc.

A wonderful corollary also results from the use of the spectroscope, namely, the existence of many stars known as "spectroscopic binaries." As seen even with the most powerful telescope such a star is a single point of light, but if the spectral lines are duplicated we know that the source of light is double, and that one component is approaching us and the other receding from us. In this way the orbits and relative masses of these visually inseparable stars are determinable. The number of known double stars, including both visual and spectroscopic ones, is already large, and Campbell, of Lick Observatory, has expressed his opinion that one star in six is double. Some of them revolve so near to one another and in such a plane that they partially eclipse one another as they revolve, and thus produce a winking light like that of a lighthouse. It would seem that we can now even tell something of the shapes of a pair of stars visually inseparable from one another. But I must not go further into this subject, and will only repeat Arago's saying, that this discovery of Herschel's has "le plus d'avenir."

It is a figure of speech to refer to the stars as fixed, for a large number of them possess a measurable amount of "proper motion" relatively to their neighbors. The existence of double stars was discovered by the observation of their movements, and thus the study of proper motions is linked to the subject of which I have just been speaking. Some few proper motions had been observed by earlier astronomers, but when Herschel took up the subject proper motion had not been accurately measured in any case.

If a man is walking through a wood the trees in front of him seem to be opening out before him, whilst those behind seem to be closing together. In the same way if our sun is moving relatively to the center of gravity of all the stars, the stars must on the average seem to move away from the point towards which the sun is travelling, whilst they must close in towards its antipodes. These two points are called the apex and antapex of the sun's path.

Now Herschel concluded that there was something systematic in the proper motions of the stars, and that there was a point in the constellation of Hercules from which the stars were on an average receding, and that similarly they were closing in towards the antipodal point. The first of these is the sun's apex and the second the antapex. These conclusions were drawn from the motions of comparatively few stars, but the result has been confirmed subsequently from a large number. Moreover, we have now learned by means of the spectroscope that we are travelling towards Hercules at the rate of about sixteen miles a second.

During these last few years this grand discovery of Herschel's has gained a great extension at the hands of Kapteyn and of many others, and it has been proved that other systematic motions of the stars are discoverable. The time at my disposal will not permit me to pursue this subject further, but I may say that it now appears that if we could view the universe from the center of gravity of the stars of the Milky Way, we should see a current of stars coming from a definite direction of space and penetrating our system.

What a vista of discoveries do these ideas open up to the astronomer! Some centuries hence the sun's apex may have shifted, and we may perhaps learn that the solar system is describing the arc of some colossal orbit. The drift or current of stars may also have begun to change its direction, and our descendants may have begun to make guesses as to its future course and as to its meaning. But whatever developments the future may have in store, we should never forget that the foundation of these grand conceptions of the universe was laid by Herschel. Holden ends his "Life of Herschel" with words which may also serve as a fitting end to my lecture:

As a practical astronomer he remains without an equal. In profound philosophy he has few superiors. By a kindly chance he can be claimed as the citizen of no one country. In very truth his is one of the few names which belong to all the world.

George H. Darwin

PAUL CASPAR FREER. AN APPRECIATION

It is only a little over a decade since America broke out of her chrysalis and took flight into the large world beyond the range of her time-honored coast lights and began to shake off a little of her provincialism. At her farthest outpost she was fortunate in having sent out many able men. Among those was Paul Caspar Freer, who for ten years has been the director of the Bureau of Science of the government of the Philippine Islands. He went there at a time when the kings and captains had not yet departed and before the shouting had entirely died away. His work was not to run down *ladrones* nor to lend a voice to the tumult incident to a period of reconstruction. He set to work, with little funds and no sympathy, save from a very few, to organize what has become to-day the leading scientific organization in the orient. The writer, who is proud of having served under Dr. Freer for six years, knows what he went through, in that time; of the bitter opposition and criticism he had to stand, not only from some of the natives (they must be forgiven), but from many of his countrymen, who ought to have known better (which can be forgiven, but not so easily).

Dr. Freer brought to his work a superb training, M.D. at Rush Medical and Ph.D. at Munich, a large view of scientific problems and their practical bearing and an almost painful regard for accuracy and detail, which I sometimes think can be got only in the German schools. I think I am safe in saying that Dr. Freer read and read carefully (and some of us know how ruthlessly) every article on whatever subject which has appeared in the *Philippine Journal of Science*, through the six years of its existence. This is the thing he lived for, and I have had the satisfaction of knowing that this journal is highly regarded in Europe and that over there he was one of the best known of all Americans in the east. But not so in America, where, I regret to say, the ignorance of our own possessions is surprising.

When the man in the street, the "get-rich-quick" schemer and some of the politicians were striving to commercialize the work of the bureau and pressure was being brought to bear on the staff, in that time when ideals in our work seemed about to suffer, when we young and inexperienced ones were in danger of losing sight of the lasting results, the work that would tell, the tall gray-haired familiar figure would loom up in the doorway and then would ensue such a talk as only a big man, a real scientist, can give, and we would take heart again. Those were times of great inspiration to us, and now that his voice will no longer be heard in those halls, we must live on the memory of it. How soon everything becomes a memory!

The work of the bureau will continue, another hand will guide, may be in a larger way still, or in a smaller way; but we, the workers, at least will miss the master.

Dr. Freer had not been well for the last two years, and after returning from a trip with the Secretary of the Interior, the Honorable Dean C. Worcester, into northern Luzon, where he hoped to recuperate, died in Baguio, on April 18, at a little over fifty years of age.

Warren D. Smith

May, 1912

THE MASTER'S DEGREE AT RUTGERS COLLEGE

Upon unanimous recommendation of the faculty the trustees of Rutgers College at their recent meeting adopted the following report of the faculty committee on graduate degrees:

Your committee on graduate degrees submits for the consideration of the faculty and for its action the following principles and consequent changes of policy in the granting of the master's degree, and recommends their adoption:

Two principles stand foremost: first, the master's degree should be given a distinct and definite place among academic honors; secondly, the degree should be held in the esteem due a higher degree. Those colleges and universities which grant it to graduate students only after at least one year's residence have thereby tried to restore it to honor, but they have failed to give it a distinct place, for it is usually merely a preliminary step towards the doctor's degree, to be forgotten if that degree is won, or to be a consolation to those who fail. In short, the course of study, the method of study and the aim of the student, all make it a doctor's degree of an inferior type; and as such it is often a reproach to the student in later years if it remains his final higher degree. On the other hand, those universities and colleges which grant it *in absentia* or after the completion of courses in medicine, law or divinity are either making it still less honorable or are making it a second degree for precisely the same work and both superfluous and meaningless. This is felt so generally to-day among able and right-minded students that few are willing to seek the degree under these latter conditions.

To the small college belongs especially, we believe, the task of rehabilitating this degree. Few small colleges are in a position to give adequate courses and facilities of research to candidates for the doctor's degree and it is often their duty to urge such students to go elsewhere; whereas, in the case of the master's degree, provided this degree is rehabilitated properly, the small college may be able to offer excellent opportunities to the student, to do so without great cost to the treasury of the college, and to compete successfully with the larger universities.

Finally, it is the belief of your committee that there are an increasing number of men and women graduating from our colleges who are not fitted or who do not wish to devote themselves to the longer and profounder study and original research required for the doctor's degree, but who do desire to pursue further their college studies in some chosen direction and who might do so with great profit to themselves and to the community; especially is this true of those young men and women who intend to teach in the elementary and secondary schools and of those students who are about to enter our theological seminaries. Moreover, it is our belief that a few men in each year's graduating class at Rutgers belong to this group and should be encouraged to study at Rutgers for the higher degree. We have already three fellowships for whose administration we are responsible and we should no doubt be glad to receive further endowments of this sort.

Hence it seems to us both fitting and progressive that Rutgers College should seek to solve, for itself at least, this rather puzzling academic problem.

We recommend:

First, that the master's degree be regarded by the faculty of Rutgers College as a degree to be given after extended liberal study and not, as in the case of the doctor's degree, after intense application to one subject and to original research;

Secondly, that the studies pursued by the candidate for this degree constitute a distinct course by themselves as they would if he were studying law or divinity;

Thirdly, that this course consist of three subjects to be pursued by the student for two years, ordinarily in residence at Rutgers; equivalent graduate courses pursued at another institution may, however, be substituted for the first year's requirements;

Fourthly, that the character of such studies shall not differ essentially from that of the elective courses now widely offered to seniors in our colleges; in other words, that their character should be elementary and liberal;

Fifthly, that no student graduating from Rutgers College after 1912 be granted the master's degree on the basis of the present requirements.

Submitted to the faculty April 19, 1911.

Austin Scott,
J. Volney Lewis,
Walter T. Marvin,
Committee

MUSEUM BUILDINGS IN THE UNITED STATES

The writer has recently taken occasion to tabulate some statistics on museum buildings in the United States. The data were taken from the Directory of American Museums published two years ago by the Buffalo Society of Natural History. Table I. shows the source of the money with which museum buildings were erected. Table II. shows the years, by decades, the money was given or appropriated for museum buildings. Table III. shows the distribution of museum buildings in five groups of states. A map which was also prepared shows the location of the buildings. While the data given in the Buffalo publication are quite complete, it is evident that no tables like these can be perfectly accurate. They are, nevertheless, very iustructive.

TABLE I

Decades	Number of Museums	Amounts Received
1840–1849	1	$ 20,000
1850–1859	2	34,000
1860–1869	6	1,277,000
1870–1879	7	6,030,000
1880–1889	5	560,000
1890–1899	20	9,866,000
1900–1909	21	14,224,000
Unknown		5,221,000

TABLE II

Sources of Funds	Number of Museums	Amounts Received
Private donations	36	$18,958,000
Universities (indirectly some states)	15	1,382,000
Cities	10	8,599,000
State and national governments	3	7,350,000
Other sources	1	943,000

TABLE III

Groups of States	Number of Museums	Cost of Buildings
Middle Atlantic States (6)	16	$17,478,000
North Central States (15)	16	8,466,000
New England States (6)	19	4,910,000
District of Columbia	2	4,400,000
Rocky Mountain and Pacific States (11)	10	1,836,000
Southern States	2	142,000

It is evident that the growth of our museums is largely parallel with the growth of our national wealth and with the progress of higher education in our own country. It is during the last fifty years that American universities have begun to provide adequate facilities for higher education of the American youth. Museum building suffered a notable decline during the eighties. This was a period of active industrial development and of immigration into the Great Plains and to the west. To the writer the rapidly rising series of figures in the first table suggests the initial rapid growth of a great and strong nation *in its infancy.* Individual growth is most rapid at first.

The irregularities in the series show that it does not represent the activities of any great number of individuals. The series is clearly an expression of a few potent factors, psychic, inscrutable forces, acting through the medium of exceptional men. And it is well known that the average man, the average man of wealth included, is not a prophet. It requires a prophet's instincts and faith to make enormous investments looking to the awakening of living truths in the human intellect by the collection and care of what the average hard-headed business man would scorn as "dry bones."

Table III. and the map indicate roughly the geographic distribution and the course of westward travel of the scientific mind of our nation. It has blazed a trail from Boston via New York and Philadelphia, to San Francisco. They show also the lingering effects of the world's most cruel war. Museums are the creations of intellect and wealth. Our great civil war destroyed the wealth of the south. Hence the insignificant sum spent for museums in the south. A large vacant area appears in the southwest. The straight lines on the map, radiating from a point in the south part of this space, show the shortest distances to the nearest museums, where a naturalist in this region can take his collection for study. The indices at the proximal ends of these lines point to a place where the great museum of the southwest should be reared, a modern temple of science on the

Mediterranean of the Occident. Here is an exceptional opportunity for the exceptional man. Will he see it?

J. A. Udden

Austin, Texas,
April 15, 1912

REGENTS OF THE SMITHSONIAN INSTITUTION

Dr. Andrew D. White has been reappointed, by joint resolution of congress, as a regent of the Smithsonian Institution for six years. Dr. White received his first appointment to this office in the year 1888 and upon the completion of the present term he will have served the institution for thirty years. The vacancy in the board caused by the resignation of Dr. James B. Angell, ex-president of the University of Michigan, who was a regent from January 19, 1887, to January 15, 1912, has been filled by congress by the appointment of the Honorable Charles W. Fairbanks. With the appointments mentioned, the roll of regents is now complete. It is as follows: James S. Sherman, Vice-president of the United States, chancellor; Edward D. White, Chief Justice of the United States; Shelby M. Cullom, member of the Senate; Henry Cabot Lodge, member of the Senate; Augustus O. Bacon, member of the Senate; John Dalzell, member of the House of Representatives; Scott Ferris, member of the House of Representatives; Irvin S. Pepper, member of the House of Representatives; Andrew D. White, citizen of New York; Alexander Graham Bell, citizen of Washington, D. C.; George Gray, citizen of Delaware; Charles F. Choate, Jr., citizen of Massachusetts, John B. Henderson, Jr., citizen of Washington, D. C.; and Charles W. Fairbanks, citizen of Indiana.

SCIENTIFIC NOTES AND NEWS

Jules Henri Poincaré, the great mathematician and man of science, died on July 17. He was born at Nancy on April 29, 1854.

The University of Oxford has conferred the degree of D.Sc. on the following foreign delegates attending the celebration of the 250th anniversary of the foundation of the Royal Society: Dr. Backlund, director of the Imperial Observatory, Pulkowa; Dr. Brögger, professor of mineralogy and geology at Christiania and rector of the university; Professor Lippmann, president of the Académie des Sciences, Paris; Professor Scott, Blair professor of geology and paleontology at Princeton University; Dr. Waldeyer, professor of anatomy and director of the anatomical institute in the University of Berlin; Dr. Zeeman, professor of physics at Amsterdam.

The degree of LL.D. was conferred on Professor A. H. Purdue, by the University of Arkansas, upon his retirement from that institution in June. For sixteen years he had been professor of geology there, and *ex-officio* state geologist of Arkansas since 1907. He is now state geologist of Tennessee.

At the last annual commencement of Lehigh University the honorary degree of doctor of science was conferred on Dr. James E. Talmage, formerly professor of geology in the University of Utah, and on Mr. James Gayley, of New York City.

Washington College, Chestertown, Md., conferred the degree of doctor of science on Dr. J. S. Grasty, professor of geology at the University of Virginia, at the annual commencement, when Professor Grasty delivered the address to the students.

On the occasion of its fiftieth anniversary, the Belgian Chemical Society has elected as honorary members all those who have received the Nobel prize, namely, Messrs. Arrhenius, von Baeyer, Buchner, Fischer, Ostwald, Ramsay, Rutherford and Wallach and Mme. Curie.

Dr. Francis H. Champneys has been elected president of the Royal Society of Medicine, London.

Professor Jeremiah W. Jenks, of Cornell University, has been appointed financial adviser to the Chinese republic.

Dr. E. de Wildman has been appointed director of the Brussels Botanical Garden.

Mr. William Odling, M.A., F.R.S., has been elected an honorary fellow of Worcester College, Oxford, on his resignation of the Waynflete professorship of chemistry after a tenure of forty years, and his consequent vacation of the professorial fellowship, which he has held for the same period at the college.

Mr. William McDougall, F.R.S., Wilde reader in mental philosophy at Oxford, has been elected an extraordinary fellow of Corpus Christi College.

It is stated in *Nature* that the John Harling fellowship for the encouragement of the study and research in physical science, in the University of Manchester, has been awarded to Mr. H. G. J. Moseley, who was until recently an assistant lecturer and demonstrator in the department of physics in the university, and to Dr. T. S. Taylor, now instructor of physics in the University of Illinois.

M. Armand Gauthier, professor of chemistry in the medical faculty of the University of Paris, has retired.

Professor Johannes Gad, who last year retired from the professorship of physiology at Prague, has celebrated his seventieth birthday.

We learn from *The Observatory* that Mr. B. D. Evans, computer at the Royal Observatory, Greenwich, has been appointed first assistant at the Hongkong Observatory. The director at Hongkong is now Mr. T. F. Claxton, formerly superintendent of the Mauritius Observatory, and previously on the staff of the magnetic and meteorological department at Greenwich. Mr. Jeffries, now the chief assistant, was also a member of the Greenwich staff.

Dr. William J. Hickson, M.D., has been appointed director of the division of medical research in the department of research of the Vineland Training School, Vineland, New Jersey.

Dr. J. C. Arthur, of Purdue University, gave a course of lectures on plant pathology, the first week in July at the Macbride Lakeside Laboratory, the summer school established by the alumni of the Iowa State University on Lake Okoboji, Iowa.

The lecture to the Congress of the Royal Sanitary Institute, which will be held at York from July 29 to August 3, will be delivered by Professor Karl Pearson, F.R.S., his subject being "Eugenics and the Public Health." Professor H. R. Kenwood will give the popular lecture on "The Healthy Home."

During the past six months the value of the library of the Chemists' Club, New York City, has been notably increased, first by the generous gift of Mr. Herman Frasch of $10,000, an endowment fund the interest of which is to be used exclusively for the purchase of new books, and second by large gifts by Professor Chandler of 3,200 volumes, by Professor Mallet of 540 volumes and of approximately 700 volumes from members, publishers and authors.

A committee has been formed with Mr. Austen Chamberlain as chairman to increase the endowment of the London School of Tropical Medicine. Subscriptions amounting to £15,000 have been received.

The Paris Academy of Sciences has made seventeen grants for scientific research from the Rowland Bonaparte fund varying in amount from 2,000 to 3,000 francs.

The Academy of Sciences, Letters and Arts of Bordeaux will celebrate the bi-centenary of its foundation on November 11 and 12 of the present year.

The planks in the platforms of the Democratic and Republican parties in regard to public health are as follows. Democratic: "We reaffirm our previous declarations advocating the union and strengthening of the various governmental agencies relating to pure foods, quarantine, vital statistics and human health. Thus united and administered without partiality to or discrimination against any school of medicine or system of healing, they would constitute a single health service, not subordinated to any commercial or financial interests, but devoted exclusively to the conservation of human life and efficiency. Moreover, this health service should cooperate with the health agencies of our various states and cities without interference with their prerogatives, or with the freedom of individuals to employ such medical or hygienic aid as they may see fit." Republican: "It will strive not only in the nation, but in the several states, to enact the necessary legislation to safeguard the public health; to limit effectively the labor of women and children; to protect wage-earners engaged in dangerous occupations; to enact comprehensive and generous workmen's compensation laws, in place of the present wasteful and unjust system of employers' liability, and in all possible ways to satisfy the just demand of the people for the study and solution of the complex and constantly changing problems of social welfare."

The German state returns of births and deaths in 1911 continue to confirm the characteristics of the returns for Prussia. In Würtemburg the excess of births over deaths was only about 25,000, as compared with more than 29,000 in 1910, and over 30,000 in previous years. In Würtemburg, at any rate, it is recognized that the downward tendency will continue, and the Statistical Office calculates that after 1915 there will be a reduction in the number of children for whom provision has to be made in the elementary schools.

The *Journal* of the American Medical Association states that the institute founded by the efforts of Professor His for biologic and therapeutic research on radium in the royal Charité has been opened. The aim of the institution is the investigation of the therapeutic effects of radio-active substances such as radium, mesothorium, radiothorium, etc., and their decomposition products. It possesses laboratories for chemical, zoological and botanical research and a complete equipment for physical measurements. In all there are about fifteen places for research workers. The institute is connected with a polyclinic in which internists, surgeons and other interested specialists will have opportunity to treat patients with radiation apparatus of various forms and strength, emanators for inhalation in closed rooms, apparatus for drinking the emanations, and other forms of application. The institute is founded through a fund appropriated by the Kaiser Wilhelm Society for Scientific Research, as well as by grants from various industrial companies. The management is in the hands of Privy Councilor His, whose representative is Dr. Gudzent. He is supported by a commission to which Professors Kraus, Orth, Lesser, Hildebrand, Bier, Zuntz, Hertwig, Hahn and Marckwald have assured their cooperation. Also a permanent physicochemical collaborator has been secured.

UNIVERSITY AND EDUCATIONAL NEWS

As has been stated in Science, the regents of the University of Michigan legislated for the reorganization of graduate studies, by providing for the establishment of an autonomous graduate department, to be governed by its own dean, and by an executive board of seven, together with the president, *ex officio*. The necessary appointments have now been made, as follows: Dr. K. E. Guthe, professor of physics, has been elected to the deanship, while the board is to consist of the president; Dr. M. E. Cooley, dean of the department of engineering; Dr. V. C. Vaughan, dean of the department of medicine; Dr. H. C. Adams, head of the department of political economy; Dr. R. M. Wenley, head of the department of philosophy; Dr. F. N. Scott, head of the department of rhetoric; Professor H. M. Bates, dean of the department of law, and Dr. M. Gomberg, professor of organic chemistry. The new executive will take office on October 1, and will probably devote next year to a thorough consideration of future policy.

Whitman College, Walla Walla, Washington, has received from seven hundred donors a fund amounting to more than $200,000.

St. Francis Xavier College is to be united with Fordham University, New York City. The St. Francis Xavier grammar and high school will be maintained.

The new four-year course which has been outlined by the College of Agriculture, of the University of Illinois, has the first year's work prescribed and one half of the work of each semester of the sophomore year. The remainder of the time is given over to specialization in soils, crops, agricultural teaching, horticulture, farm mechanics, dairying or animal husbandry. A new college circular describing this course will be ready for distribution about the middle of August.

SAMUEL L. BOOTHROYD, assistant professor of topographic and geodetic engineering in the College of Civil Engineering of Cornell University, has resigned to accept the associate professorship of astronomy and mathematics in the University of Washington, succeeding Professor James E. Gould. The trustees have promoted Paul Halladay Underwood, instructor in the college, to the rank of assistant professor and appointed him to the place vacated by Professor Boothroyd. The following appointments have also been made: Ransom E. Somers, instructor in economic geology; E. H. Kennard and T. B. Brown, assistants in physics, and R. A. Gulick, assistant in chemistry.

H. N. PARKER, of the Illinois Experiment Station, will head the division of sanitary dairying of the university next year. Professor B. R. Rickards will enter the employ of an Indianapolis manufacturing firm.

DR. ARTHUR E. HILL, of New York University, has been appointed professor of chemistry and director of the laboratory to succeed Professor Lamb.

GEORGE R. WELLS, Ph.D. (Hopkins, '12), has been appointed instructor in psychology at Oberlin College.

L. R. GEISSLER, Ph.D. (Cornell), has resigned his position as research psychologist in the Physical Laboratory of the National Electric Lamp Association, Cleveland, to become professor of psychology at the University of Georgia. He will organize and direct the new psychological laboratory to be established in connection with the School of Education. The laboratory will occupy seven or eight rooms in George Peabody Hall, the new home of the School of Education now under construction, and will be furnished with all modern equipment.

WILLIAM E. BARROWS, JR., has been appointed professor of electrical engineering at the University of Maine. For the past six years he has been assistant professor of electrical engineering at the Armour Institute of Technology.

DR. W. H. WARREN, connected during the past year with the department of chemistry of Clark College, has recently been appointed professor of chemistry in Wheaton College, Norton, Massachusetts.

PROFESSOR CHARLES E. DECKER, M.S. (Chicago), has been appointed assistant professor of geology and biology at Allegheny College.

DR. FRANK ELBERT WHEELOCK, instructor in physics in the University of Missouri, has been appointed professor of physics in Mount Allison College, Sackville, New Brunswick.

THE following appointments have been made in consequence of the new grant in the University of London made by the London County Council for the increase of the university professoriate: Dr. J. A. Fleming, D.Sc., F.R.S., professor of electrical engineering (to teach at University College); Dr. Arthur Dendy, D.Sc., F.R.S., professor of zoology (to teach at King's College).

PROFESSOR V. BJERKNES, of the University of Christiania, has been offered the chair of geophysics at Leipzig.

DR. JEAN BRUNHES, professor at Lausanne and Freiburg, has been called to the chair of anthropogeography in the Collège de France.

DISCUSSION AND CORRESPONDENCE

"GENES" NOT MADE IN GERMANY

TO THE EDITOR OF SCIENCE: The new version of "genes" in the issue of May 24 carries a reminder of Mark Twain's "jumping frog." Darwin's word pangen is taken into German to alter the vowel quantity and then comes back into English accompanied by a superfluous letter and a new system of philology elaborated to justify the "genes" and "pangenes" that adorn the pages of recent publications on genetics.

The custom has been to use Latin transliterations of Greek derivatives, but scientific literature is now to have a more Teutonic flavor. The new system need not be confined to genetics, of course, nor even to biology. The same reasons can be urged for oxygene as for pangene. Scores of terms have been based on the same root, γεν, but hitherto with a short vowel, as in the Greek. Some philologists add a letter in forming such a word as clone, where the original Greek vowel is long, but this has nothing to do with Dr. Shull's "general law of English philology" that would lengthen short vowels to enable Greek derivatives to be pronounced with a German accent. In this case Johannsen's correct word "gen" was displaced by a linguistic monstrosity, "gene," because the latter was supposed to sound more like German, and because "the German word '*Pangen*' better expresses the meaning involved than does the English word 'pangen.'" The new final "e" symbolizes the magically improved connotation acquired by Darwin's word pangen in passing from English into the hallowed precincts of the German language. It replaces the italics, capitals and quotation marks otherwise required to differentiate the more expressive German "*Pangen*" from the ordinary English "pangen." The mistake, as now appears, was not a merely casual adoption of the German plural "*Gene*" as an English singular, but a deliberate substitution of an erroneous new singular "gene," anomalous alike in German, Greek or English. Dr. Shull does not state when, where or by whom this change from "gen" into "gene" was determined, but these details are of no importance now that the method has been explained. It would have been easier to bestow "gene" and "pangene" on the French, who use "*oxygène*" and a whole class of similar terms, but the German derivation is more ingenious.

Regarding the phenotypes, little need be said. Dr. Shull reasserts the reality of phenotypes, and even insists with italics that "statistical investigation may *discover, measure* and *describe* phenotypes." But if it be true that "phenotypes and genotypes exist among Mendelian hybrids," or elsewhere in nature, they must be the names of classes or groups of animal or plant individuals distinguished by the possession of certain characters or gens. Such group names are usually considered as collectives, but Dr. Shull maintains that phenotypes "must always be abstractions." Evidently the new science of genetics is to have an original system of metaphysics as well as of philology.

O. F. Cook

Bard, California,
June 17, 1912

PROPOSITIONS FOR CHANGES IN THE INTERNATIONAL CODE OF ZOOLOGICAL NOMENCLATURE

Attention of zoologists is invited to the rule that all propositions for changes to the International Code must be in the hands of the Commission at least one year before the meeting of the International Congress.

Formal notice of the exact date of meeting has not yet reached me, but I hope to have my first report to the Commission prepared for mailing not later than September 1. About that date I shall also send to Science and to the *Zoologischer Anzeiger* a complete list of the propositions that have been sent to me.

It is a great satisfaction to the Commission to note the increased and more general interest exhibited by zoologists in nomenclatorial matters, and I take the liberty of repeating a statement made on several former occasions, namely, that the Commission welcomes most heartily correspondence and suggestions from all zoologists.

C. W. Stiles,
Secretary, International Commission on Zoological Nomenclature

THE PEI YANG UNIVERSITY

To the Editor of Science: A note by Consul General S. S. Knabenshue, of Tientsin, China, regarding vacancies in the staff of the Pei Yang University, of that city, published in *Daily Consular and Trade Reports* of July 8, seems likely to deluge me with inquiries and applications, and I would be glad if you would aid me in forestalling them by publishing this statement. There are no vacancies in the staff of the Pei Yang University at present, Dr. George I. Adams, of the United States Geological Survey, having been recently appointed to the chair of geology and mining, and Dr. H. V. Fuller, of Zürich University, to the chair of chemistry. Next year the professorship of railway engineering will be vacant, but only properly qualified persons should apply, as the university, though small, maintains a high standard and the salary offered is sufficient to command the services of able and experienced men. I have received many applications for positions which do not exist, and beg to point out that, as stated in Science, March 1, 1912, the professorships now filled by foreigners are: law, two; economics and history, one; chemistry, one; geology and mining, one; metallurgy, one; civil engineering, two; mechanical engineering, one; railroad engineering, one. As stated above, none of these are now vacant. There are no professorships in mathematics, physics, biology, zoology, botany, agriculture, pedagogy and kindred subjects, nor are any likely to be created.

Thomas T. Read

San Francisco, Cal.

SCIENTIFIC BOOKS

Technology and Industrial Efficiency. A Series of Papers Presented at the Congress of Technology, opened in Boston, Mass., April 10, 1911, in Celebration of the Fiftieth Anniversary of the Granting of a Charter to the Massachusetts Institute of Technology. McGraw-Hill Book Company. 1911. Pp. 486.

This volume of papers, covering a large variety of topics in applied science, derives its interest possibly as much from the occasion which has called it forth, as from its contents. The charter of the Massachusetts Institute of Technology was signed by Governor Andrew on April 10, 1861. The fiftieth anniversary of this event was taken advantage of for the inauguration of a congress of technology which lasted through several days, and to which the public was invited, to listen to the reading of papers contributed by graduates and professors of the institute.

The occasion was thus, in some degree, a celebration of the fiftieth anniversary of the institute, and a demonstration, so far as it was needed, of the prominent position in applied science which had been won by it and by its graduates.

It is an interesting question, in how short a time may an institution of learning, without substantial state aid or endowment, dependent almost wholly upon its own resources and the merits of what it has to offer, attain to a commanding position among institutions of learning? The lesson which has been taught by the institute is, in this respect, most instructive. Here is an institution which, in the short space of considerably less than fifty years, has become one of the leading institutions of its kind in this country or in the world, and it has attained this position solely by its own merits and exertions, with a small endowment, with little aid from the state—until within a very few years—and obliged to depend, therefore, for its maintenance and progress upon the tuition fees from students and such scattering gifts as it might receive from time to time. This position of leadership has already been held by the institute for at least fifteen or twenty years, so that from the date of the first small beginnings, when the classes met in hired quarters in the business section of the city of Boston, the school has developed in a third of a century into a position of unquestioned leadership.

Under these conditions it is not unnatural that its graduates, faculty and corporation should take advantage of the fiftieth anniversary of its birth to celebrate the progress which has been made. The papers presented at the congress have been edited and collected in the volume referred to above.

These papers, covering, as they do, the whole field of applied science, differ widely in character and subject. There are but few on any one topic, and the specialist will find but little in the volume to enlarge his detailed knowledge. Nevertheless, the papers have been kept somewhat non-technical in form and designed to be of general interest to the applied scientist, and this object has been admirably attained. The applied scientist, in whatever branch of engineering he may be engaged, will be able to read most of the papers with interest and profit, and will find that they will enlarge his view of the field of engineering. Many of them deal with the progress in certain branches of science within the last few years, giving a summary of the main events. There is little that is strictly technical in the volume, and the writer recalls but one paper which is accompanied by any mathematical formulæ.

The volume opens by a paper by President Maclauren, entitled "Some Factors in the Institute's Success." In this paper Dr. Maclauren outlines most admirably the main features which have contributed to the rapid and great success of this school. Among the important contributing elements he names the fact that the school was born in Boston, where the value of education was fully appreciated, and where the new venture received moral, if not immediate financial support; then the impetus which applied science had taken on at the time of its birth, owing to the great discoveries in engineering which had just preceded it; and finally, as a cause to which Dr. Maclauren attributes special importance, the fact that there has never been any uncertainty or indefiniteness as to what the institute is aiming at in its scheme of education. The institute was founded to emphasize *the importance of the useful,* using the term in its broadest sense and not limiting it simply to that which aids a man to earn his bread and butter, but understanding it to mean whatever cooperates in enabling a man to make his life of greater use to himself and to the community. As contrasted with the scholastic education which devotes itself to the abstract, and sometimes even decries that which is useful, the institute maintained that utility was the first object in the study of anything. In accordance with this idea, the method of teaching adopted at the institute has been termed "learning by doing," and Dr. Maclauren gives it as his belief "that the do-it-yourself method has been the greatest factor in the success of the institute." Whether this is true or not, there seems no question of the fact that the establishment of this school has had a great influence upon the traditional college education, and it probably is not too much to say that the trend in education to-day is in the direction in which the institute has always moved.

The technical papers in the volume are sixty-eight in number, averaging, therefore, only about seven pages in length. They are divided into six sections.

Section *A* deals with scientific investigation and the control of industrial processes, and contains seventeen papers, treating of such subjects as the conservation of metal resources, some causes of failure in metals, metallography, improvements in cotton bleaching, the gas industry, fire prevention, the utilization of blast furnace wastes, reclamation in the west and similar topics.

Section *B* treats of technological education in its relations to industrial development, and consists of thirteen short papers, several of which emphasize the importance of the method and aim at the institute, the value of a thorough training in engineering, and the influence of the institute upon education.

Section *C* treats of administration and management, and contains nine papers, several of them devoted to the modern subject of scientific management. One of these, entitled "An Object Lesson in Efficiency," is contributed by Mr. Lewis, president of the Tabor Manufacturing Company, of Philadelphia, the company in which the principles of Mr. F. W. Taylor have been most thoroughly carried out. The applicability of scientific management to various branches of industry are discussed in this section, and one of the most interesting papers in the volume is that of Mr. H. G. Bradlee, of the firm of Stone & Webster, entitled "A Consideration of Certain Limitations of Scientific Efficiency," in which he points out the fact that scientific management has distinct limitations which, at the present time, we may be apt to overlook. We are an hysterical nation, and the pendulum swings rapidly from extreme to extreme. After reading the highly colored accounts of the results attained by scientific management as depicted by some of its enthusiasts, and after being solemly assured that the railroads of this country could save a million dollars a day by introducing the principles of scientific management, it is refreshing to read a calm, dispassionate, but keenly analytical paper like that of Mr. Bradlee, and, after finishing it we shall find ourselves less enthusiastic but more sane.

Another important paper in this section is that contributed by Mr. S. M. Felton, president of the Chicago Great Western Railroad, on the scientific management of American railways. This is the longest paper in the volume covering, with cuts, 46 pages. It gives a very interesting account of the development of American railways since 1850, with cuts illustrating the differences between rolling stock at the present time and forty or fifty years ago, and many interesting facts, figures and historical comparisons, both as to the physical characteristics of railways and the operating results.

Section *D* treats of recent industrial development, and includes 15 papers treating of improvements in electric lighting, illuminating engineering, gasolene engines, electric propulsion, the mechanical handling of materials and mail, electro-chemistry power plants, ore-dressing, etc.

Section *E* treats of public health and sanitation, and contains nine papers. This section is especially indicative of the work of the institute, for this school, it is fair to say, has been the leader in the training of sanitary engineers. The graduates from its department of sanitary engineering have taken a foremost part in the modern improvements in methods of water supply, filtration, and sewage disposal, and are found occupying positions of responsibility all over the country. The part that the institute has played in this development is traced in one of these papers by Professor George C. Whipple, himself one of the most eminent examples of the leadership of the institute in this department. Another paper, by Professor Phelps, gives an account of the work of the sanitary research laboratory and sewage experiment station, a novel and important adjunct of the institute.

Section *F* is devoted to architecture. In comparison with the splendid architectural department of the institute and the eminence of the men who have graduated therefrom, this section is the least satisfactory in the volume. It contains but four papers, two of them written by civil engineering graduates, and one by a mechanical engineering graduate, only one being contributed by a graduate in architecture. Possibly this is due to the fact that in pure architecture there may have been less development in recent years than in the other branches of applied science, most of the improvements in the construction of buildings having been of an engineering rather than of an architectural nature.

As a whole, the volume will well repay reading. Almost everybody will find material of interest in it, and will be struck with the excellence of the papers as a whole, and especially by the fact that one institution should, in so short a time, have been able to turn out so many men who have attained to leading positions as applied scientists. In this respect, however, the volume is almost as noticeable for the names that are absent as for those that are represented among the authors. Some of the most eminent of the institute graduates have not contributed papers, and it is probably safe to say that the school is quite capable of producing another similar volume of equal size and equal interest.

Geo. F. Swain

The Mechanics of Building Construction. By Henry Adams, M.Inst.C.E., M.I.Mech.E., F.S.I., F.R.San.I., M.S.A., etc. Longmans, Green, and Co. Cloth; $5\frac{1}{2} \times 9$ in. Pp. xi + 240; 589 figures. $2 net.

A rare combination of qualities is requisite to the authorship of a really good engineering text book. In addition to the literary polish of the novelist one must have the broad point of view of the practising engineer as well as the didactic skill supposed to characterize the college professor. The author of this book is an engineer who has received many tokens of confidence and esteem from his fellow engineers, he has written many papers and books and for thirty-five years he was a college professor. His product, however, can hardly be called a really good book.

The author is chief examiner on engineering for the London Board of Education. At the request of this board a few years ago he gave to a group of teachers a series of lectures upon the "Mechanics of Building Construction, with the object of perfecting their knowledge of the subject and at the same time illustrating the manner in which it should be taught." These lectures have been expanded and form the basis of the present text.

In giving the original lectures and in this work of revision it may be conjectured that the author's duties as examiner were ever present in his mind and unconsciously influenced his style of writing. The attempt is made to explain methods of estimating the strength of all structural parts met in English building practise. The method chosen is generally that of working out particular problems rather than developing the principles involved. In those parts where some attempt has been made to develop principles, the writing seems very careless. In some cases the simplest things are explained and some of the important ones are omitted. While a considerable portion of the book naturally has to do with flexure, the simple principles of the theory of flexure are not given. It is apparent that the writer has not had the same class of readers in mind while he was writing different parts of the text.

The book will doubtless be of assistance to the men who are preparing for the examinations referred to. It can hardly be recommended to the general student. It seems, however, especially well fitted for the use of an architect or builder who has taken up his work without a proper education; his familiarity with the subjects treated will enable him to read the parts in which he is interested with some understanding; but it is a question whether such a man should be encouraged to make his own calculations unless he is willing to begin at the beginning in his study of the subject; otherwise it is almost certain that he will make mistakes due to the fragmentary character of his information.

The book is arbitrarily divided into thirty lectures for the supposed convenience of teachers who, while giving lectures upon the subject, may wish to follow the author in a servile manner. Graphical solutions are used throughout in preference to algebraic solutions; the figures illustrating the text are very numerous. The subjects treated cover fairly well the simpler problems likely to be met in building work in England; they do not include steel building construction as practised in America.

O. H. Basquin

Northwestern University

The Evolution of the Vertebrates and their Kin. By William Patten, Ph.D. Philadelphia, P. Blakiston's Son and Co. 1912. Pp. xxi + 481.

Twenty-two years ago there appeared in the same number of the *Quarterly Journal of Microscopical Science* two papers, one by Professor Gaskell and the other by Professor Patten, both maintaining the inadequacy of all the theories that up to that time had been proposed to account for the origin of the vertebrates and advocating a new one, namely, the derivation of the vertebrate phylum from crustacean-like ancestors. For more than two decades both authors have devoted themselves to working out the details of their theories and we now have the results of their labors collected into single volumes, that by Professor Gaskell having appeared about a year ago, while that of Professor Patten now lies before us.

It must be confessed that a certain amount of scepticism will obtrude itself into the consideration of both works, not from any predilection for older theories, but on account of the fact that on a common foundation the two authors have built up systems of homologies utterly incompatible the one with the other, the result being that the reader, despairing in his search for the truth in either system, is inclined to cry with Mercutio, "A plague o' both your houses." Professor Patten's views, however, will on the whole prove the more acceptable to morphologists, since they do not show the utter disregard of certain fundamental principles of embryology so characteristic of Professor Gaskell's theory.

Professor Patten, as is well known, traces the vertebrate phylum back to an arachnid ancestry, represented by such forms as the Eurypterids, and thence traces it upwards through the Ostracoderms to the primitive arthrodire, dipnoan and amphibian forms. It will not be possible here to discuss the various homologies of arachnidan and vertebrate structures proposed in the book, such as the identification of the arachnidan limbs with the vertebrate external gills, of the arachnidan liver lobes with the vertebrate pharyngeal pouches and thyreoid, of the lemmatochord with the notochord. Nor can more than mention be made of the comparison of the lateral and parietal eyes of the arachnids with the corresponding structures in vertebrates, or of the suggestive similarity of the endocranium and branchial cartilages of *Limulus* to those of the vertebrates. But attention may be especially directed to two points that seem to be crucial for the theory, namely, the homologies of the surfaces of the body and the mode of evolution of the vertebrate brain.

The hæmal and neural surfaces of the vertebrate descendant are homologized with the same surfaces of the invertebrate ancestor whose appendages have migrated hæmally until their basal portions form the branchial arches and whose mouth has been supplanted by a new one, so that the stomodæum no longer perforates the central nervous system. A portion of the original stomodæum has become the ependymal lining of the third ventricle, another portion of it is represented by the infundibulum and hypophysis, and the new mouth is formed from what Professor Patten terms the cephalic navel, the region where in *Limulus* the blastoderm completes its investment of the yolk and which is identified with the dorsal organ of other arthropods. The cause of the closure of the original mouth Professor Patten finds in the constriction of the stomodæum by the consolidation and enlargement of the cephalic neuromeres and the evident difficulty in the way of imagining such a "cataclysmic metamorphosis," as Professor Patten rightly calls the closure of one mouth and the opening of another, he endeavors to avoid by the suggestion that it took place "during the embryonic, or larval period, the increasing volume of the yolk sphere making . . . (it) possible." In other words, he suggests that the closing of one mouth, the development of another, the transfer of the oral arches to the hæmal side and the appearance of true gill clefts all took place in the course of the life history of a single generation! Or should it be of a single individual?

With regard to the second point referred to above, Professor Patten holds that the entire arachnidan nervous system is equivalent to the vertebrate brain, the spinal cord being a later development which does not and probably never did show a division into neuromeres. But, it may be remarked in passing, in the vertebrate brain thus formed are included the hypoglossal segments, the hypoglossal nerve being the result of the segregation of special fibers from the vagus complex supplying the gills. The hypoglossal segments are, accordingly, primary constituents of the vertebrate brain, a view entirely at variance with the results of vertebrate morphology. The arachnidan fore brain consists of that portion of the brain situated in front of the stomodæum and is composed of three neuromeres. The first of these is associated with the olfactory organ and represents the olfactory lobes; the second is associated with the lateral eyes and its mushroom bodies become the cerebral hemispheres, while behind the third neuromere lies the stomodæal commissure, which is the representative of the vertebrate cerebellum! The medulla oblongata corresponds, however, to the abdominal or branchial portion of the nervous system of *Limulus* and, therefore, there is no correspondence whatever between the neural and hæmal surfaces of the vertebrate brain as far back as the region of the cerebellum, the neural surface of all this portion of the brain, including the hemispheres, the roof of the tweenbrain, the optic lobes and the cerebellum, being derived from the procephalic neuromeres and having been carried caudally by the enlargement of the cerebral hemispheres and the optic lobes. Surely one might expect to find some indications of such a remarkable translocation in the ontogeny of the vertebrate brain, and yet one will look for it in vain. If it has occurred we must leave it to the neurologists to frame an explanation of the connections of the cerebellum.

This translocation is an essential part of Professor Patten's theory and with its accuracy and that of the supposed new-formation of the mouth the theory must stand or fall. While one may admire the ingenuity displayed in discovering unexpected homologies, one must acknowledge a feeling that in many cases they but create difficulties greater even than those they were intended to obviate. Nor does one find in the theory any explanation of the most essential feature of the vertebrate nervous system, namely, its arrangement in longitudinal zones corresponding to the nerve components. Indeed, the theory makes such an arrangement impossible, and yet an explanation of this arrangement and associated structural peculiarities must be an essential part of any acceptable theory of vertebrate phylogenesis.

But while the theory must be adjudged to be at least "not proven," it must be pointed out that Professor Patten in the study of the problem has added extensively to our knowledge of the morphology of the primitive arachnids and of the Arthrostraca, an account of the latter, based very largely on the study of material contained in Professor Patten's private collection, forming one of the most interesting chapters of the book. The concluding chapters are a discussion of the author's views as to the phylogeny of the various vertebrate and invertebrate groups, summed up in a concluding phylogenetic tree. Even though one may not agree with the author's conclusions, this portion, as well as the rest of the book, will be found well worth careful study by all morphologists.

It is to be regretted that the author has not taken more pains to render the reading of the book less tedious. Not but that the presentation is satisfactory, barring many annoying orthographical errors, and the numerous illustrations are excellent both in execution and reproduction. But rarely is a figure to be found on the page where it is referred to and the reader becomes wearied turning backwards and forwards to find the figure to which his attention is directed, only to discover, when he has located it, that he must turn again to the end of the book to find an explanation of the lettering employed. And even then he will not always find what he is looking for. The index, too, is decidedly inadequate.

J. P. McM.

SCIENTIFIC JOURNALS AND ARTICLES

The contents of the June issue of *Terrestrial Magnetism and Atmospheric Electricity* include:

"The Penetrating Radiation," W. W. Strong.

"Results of some Long Series of Magnetic Observatory Observations: Colaba (1846–1905), Pola (1847–1909) and Potsdam (1892–1900)," reviewed by D. L. Hazard.

"The Physical Theory of the Earth's Magnetic and Electric Phenomena, No. V.: On the Formation of the Earth's Magnetic Field," L. A. Bauer.

"Magnetic Declinations and Chart Corrections in the Atlantic Ocean according to the Observations on Board the *Carnegie*, June, 1910, to March, 1911," L. A. Bauer and W. J. Peters.

BOTANICAL NOTES

Laboratory botanists who are looking for a constant temperature apparatus will do well to read W. J. S. Land's paper on this subject in *The Botanical Gazette* for November, 1911, where the descriptions are illustrated by working drawings quite sufficient to enable a good workman to reproduce the apparatus at much less cost than otherwise.

Botanists will read "The Wilting Coefficient for Different Plants and its Indirect Determination," by L. J. Briggs and H. L. Shantz (Bull. 230, Bureau of Plant Industry, U. S. Dept. Agriculture), for two purposes: (1) The very considerable amount of valuable physiological and ecological information contained in the paper, and (2) for the descriptions and illustrations of the very ingenious apparatus devised and used by the two investigators. For the latter especially the paper is to be very highly recommended to teachers of plant physiology who are in search of effective apparatus.

Plant physiologists will find some surprising things in "A Preliminary Study of the Forced Curing of Lemons as Practised in California," by A. F. Sievers and R. H. True (Bull. 232, Bureau of Plant Industry, U. S. Dept. Agriculture, Feb., 1912). Lemons that ripen on the tree, known as "tree-ripes," constitute as a whole, "an inferior class of fruit, both as to appearance and keeping quality, and are largely consumed in near-by markets." They are therefore picked when full-grown but still uniformly green in color, and then cured in the packing house, and it is said that when so cured the lemon "has a better appearance, better keeping quality, and a considerably thinner rind." The reading of some portions at least of this bulletin is commended to plant physiologists.

While the foregoing bulletin appeals to the plant physiologist, one from the California Experiment Station (No. 196) on the "Tolerance of *Eucalyptus* for Alkali," by R. H. Loughridge, is of especial interest to the ecologist. The increasing growth of *Eucalyptus* trees of various species raised the question of the possibility of utilizing the alkali lands for such plantings, and the experiment station was asked to furnish the necessary information as to the tolerance of different species of *Eucalyptus* for the ordinary alkali salts of the soil. It appears from this bulletin that it is possible to grow good trees of several species of *Eucalyptus* upon soil which has much alkali in it, and that there is a very considerable difference in the tolerance of the different species for alkali.

Dr. B. M. Davis's paper on the "Reduction Divisions of *Oenothera lamarckiana* and *O. gigas*" (*Ann. Bot.*, October, 1911) adds to the cytology of these related forms in which the number of chromosomes in the second is twice that of the first, the author affirming as one of his conclusions that "*O. gigas* is a progressive mutant, its peculiarities being clearly associated with the changes in its germ-plasm incident upon the doubling of its chromosome number." Seventy-nine figures on three double plates illustrate the paper.

Dr. J. M. Coulter has been studying the endosperm of Angiosperms (*Bot. Gaz.*, November, 1911) and decides definitely in favor of its gametophytic nature in spite of the various nuclear fusions from which some have argued its sporophytic character. "The product of such fusions as do occur is merely an undifferentiated tissue, which practically continues the tissue of the gametophyte; that is, it is simply *growth* and not *organization*."

L. W. Sharp described (*Bot. Gaz.*, September, 1911) the embryo sac of *Physostegia* in which a curious lateral lobe develops in the antipodal region and in this eventually the endosperm forms, and into it also the embryo protrudes by the great elongation of the micropylar cell of the proembryo.

The same author and W. H. Brown publish (*Bot. Gaz.*, December, 1911) their study of the embryo sac of *Epipactis* which differs in certain details from the usual structural sequence.

N. E. Stevens in the December (1911) *Torrey Bulletin* publishes a paper on the "Dioecism of the Trailing Arbutus (*Epigea*)" in which he shows first that it is not properly heterostylous, in spite of the fact that there is much difference in the length of the styles. On the other hand, he found that it is functionally dioecious.

A VALUABLE SERVICE TO SCIENCE

The Historical Department of Iowa has rendered a most valuable service to science by procuring the preparation and publication of a sketch of the life of the naturalist, Rafinesque, accompanied by a voluminous bibliography of his many publications. In the volume entitled "Rafinesque, A Sketch of his Life with Bibliography," by Professor T. J. Fitzpatrick, we have placed before us a most readable account of the life of this gifted and eccentric man, who was so tireless a student and observer of nature. To this part of the book fifty pages are given, every page of which is full of interest. Born of French and German ancestry in a suburb of Constantinople in 1783, he lived mostly in France until 1802, when he came to America, remaining several years. Returning to southern Europe for a period, he finally came again to America, where he remained until his death in 1840.

The story of his life is told with absorbing interest and no one can run over these pages without feeling grateful to the writer who has made the eccentric hero of the story live again for us, and we may hope that many who read it will be inclined to think less harshly of his work, done, as it was, in a period when science was little recognized in this country.

The Bibliography will be a revelation to many scientific men who have known about Rafinesque only in a general way. All told the list includes 941 titles. The author says in his introduction that "the writings of Rafinesque are varied and widely scattered," and refers to the difficulty he experienced in collecting the material upon which his list is based. The list consists of titles, dates, places of publication and notes, the latter often very interesting as including historical facts not to be found elsewhere. Here and there one finds a photographic reproduction of a title page, often very quaint and old-fashioned.

After the regular bibliography a few pages are given to a list of 134 articles that refer to Rafinesque, some rather fully, and others only incidentally. The book closes with a short chapter on the portraits of Rafinesque.

One can not turn from a reading of this book of Professor Fitzpatrick's without feeling that in Rafinesque American science had a man of far more than ordinary ability, and that while eccentric and erratic he has still to be reckoned with as one who studied nature and found out many of her secrets, in the early days when naturalists were few and far between. And science owes much to the author and the Historical Department of Iowa for bringing together all this information and issuing it in this very attractive volume.

Charles E. Bessey
The University of Nebraska

SPECIAL ARTICLES

THE HISTORY OF THE GERM CELLS IN THE PÆDOGENETIC LARVA OF MIASTOR

Six years ago, when I began to study the origin of the germ cells in insects, an attempt was made to obtain specimens of the pædogenetic larvæ of certain flies belonging to the family Cecidomyiidæ. At that time I was informed by one of the best authorities on the Diptera that there were none in this country. Since then they have been discovered (October 5, 1910) by Dr. E. P. Felt and many features of their life history have been determined by him.[1] I am indebted to Dr. Felt for an abundant supply of these interesting larvæ, upon which work is now progressing.

As early as 1865 the fact that the germ cells (pole cells) of the pædogenetic Cecidomyiidæ are set aside very early in embryonic development was pointed out by Leuckart[2] and Metschnikoff.[3] Their brief descriptions were followed a year later by a more detailed account.[4] Eggs were found containing only two nuclei which were supposed to result from the division of the germinal vesicle. These nuclei continued to give rise to others by division

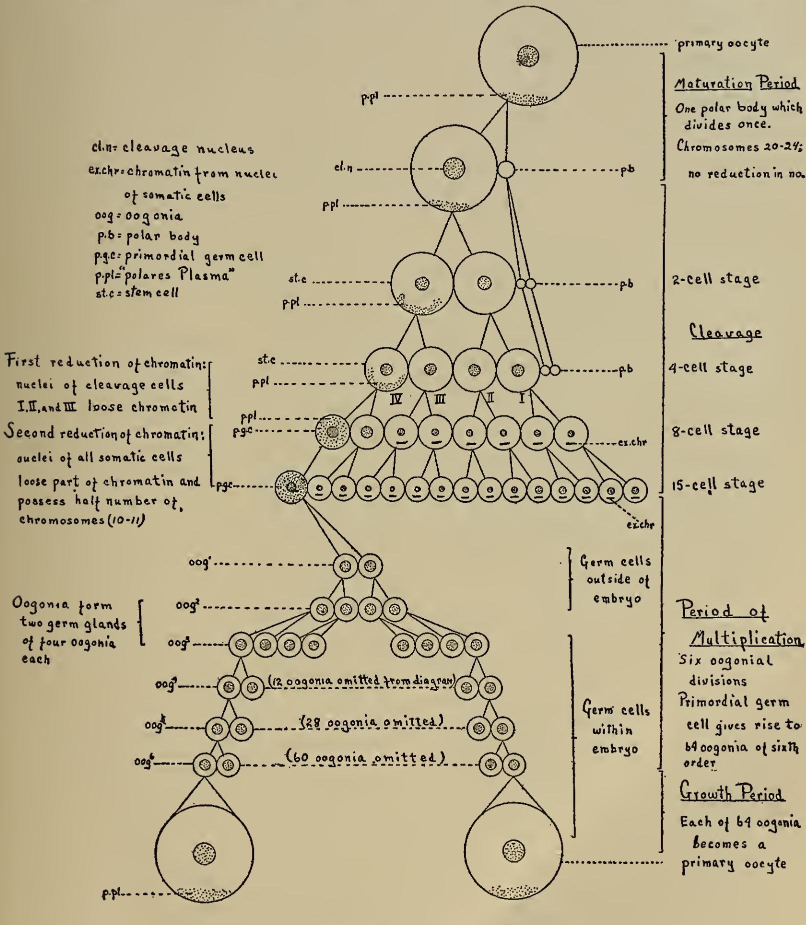
[1] Felt, E. P., "Miastor and Embryology," Science, Vol. 33, pp. 302–303, 1911; "Miastor Americana, Felt; an Account of Pedogenesis," Bul. 147, N. Y. State Museum, pp. 82–104, 1911; "Miastor," *Journ. Ec. Ent.*, Vol. 4, p. 414, 1911.

[2] Leuckart, R., "Die ungeschlechtliche Fortpflanzung der Cecidomyienlarven," *Arch. f. Naturg.*, Bd. 1, 1865.

[3] Metschnikoff, E., "Ueber die Entwicklung der Cecidomyienlarven aus dem Pseudovum," *Arch. f. Naturg.*, Bd. 1, 1865.

[4] Metschnikoff, E., "Embryologische Studien an Insekten," *Zeit. f. Wiss. Zool.*, Bd. 16, 1886.

until twelve to fifteen were produced, one of which, lying at the pointed pole of the pseudovum, became surrounded by a thick, dark yolk mass and with it separated as a distinct membraneless cell, the first pole-cell. This then divided into two and later into four cells. These four then separated into two groups of two cells each and were recognized as the



History of the Germ Cells of Miastor

FIG. 1.

primitive reproductive organs lying in their definitive positions. From 1866 until 1908 nothing was added to our knowledge of the embryonic development of these pædogenetic larvæ. Kahle,[5] however, has given a remarkably clear and detailed account of the subject and I have already been able to confirm many of his results.

The entire "Keimbahn," as described by Kahle, is shown in the accompanying diagram. The primary oocyte contains, at the posterior pole, a mass of protoplasm which stains more deeply in aniline and carmine than does the rest of the material in the egg. This substance is named "polares Plasma." From twenty to twenty-four chromosomes are present. One polar body is given off, and this divides once. One of the eight nuclei resulting from the first three divisions of the egg nucleus becomes embedded in the "polares Plasma" and is cut off by cell walls forming the primordial germ cell. During the division from the 4-cell to the 8-cell stage, three of the nuclei (I., II., III.) lose part of their chromatin, which is cast off into the cytoplasm, and is called by Kahle "Chromatinreste." The next, or 15-cell stage, includes a single primordial germ cell which contains the "polares Plasma" and possesses a large nucleus with the full amount of chromatin, and fourteen somatic cells, each of which lacks "polares Plasma," and has a small nucleus from which part of the chromatin has been cast out, and which possesses only half the number of chromosomes (10–11).

The primordial germ cell undergoes six successive divisions, thus producing sixty-four oogonia of the 6th order. At the end of the third division two germ glands are formed of four cells each. The multiplication period is followed by the growth period during which each oogonium enlarges into a primary oocyte with a nucleus containing from 21–24 chromosomes and with a mass of "polares Plasma" at the posterior pole. The origin of the "polares Plasma" was not discovered.

Miastor americana Felt agrees so far as I have been able to determine with the species studied by Kahle (*Miaster metraloas*). The "polares Plasma" is present; the primordial germ cell is set aside at the 8-cell stage; and two germ glands of four oogonia each are formed. I have not, however, been able to count the chromosomes accurately nor to find division figures of early stages which show the diminution of the chromatin. These stages I hope to find later.

The determination of the germ cells of *Miastor* seems to combine two of the methods that have already been described for other animals. The presence of a deeply staining mass of material at the posterior pole of the egg, which becomes a part of the primordial germ cell but is excluded from the somatic cells, is similar to the condition in Chrysomelid beetles, in *Cyclops,* and in *Sagitta;*[6] whereas the diminution in the amount of chromatin which takes place in the somatic cells but does not occur in the primordial germ cell is like the casting out of the chromatin from the nuclei of the somatic cells of *Ascaris.*[7]

The "Keimbahn" of *Miastor* furnishes a remarkably clear example of the continuity of the germ plasm. It likewise enables us, at least in one instance, to state the number of cell divisions that occur during the period of multiplication of the oogonia, and, indeed, the number of cell divisions from one oocyte to the sixty-four oocytes of the next generation, namely, ten. The writer is now engaged in an attempt to determine the origin of the peculiar substances (germ cell determinants) such as the "polares Plasma" of *Miastor* which have been observed in the primordial germ cells of many species of animals, and hopes to discover the rôle they play in the primary differentiation of germ cells and somatic cells.

Robert W. Hegner
University of Michigan

[5] Kahle, W., "Die Paedogenesis der Cecidomyiden," *Zoologica,* Heft 55, pp. 1–80, 1908.

[7] Boveri, Th., "Die Entstehung des Gegensatzes zwischen den Geschlechtszellen und den somatischen Zellen bei *Ascaris megalocephala,*" *Setz. Ges. f. Morph. Physiol.,* Bd. 8, 1892.

[6] Hegner, R. W., "Germ Cell Determinants and their Significance," *Am. Nat.,* Vol. 45, pp. 385–397, 1911.

AN AUTOCOLLIMATING MOUNTING FOR A CONCAVE GRATING[1]

THE usual form of mounting for a concave grating is cumbersome and has the objection that either the receiving apparatus or the source must be movable. This may be avoided by employing the method of autocollimation, using that part of the light which after being diffracted is returned toward the slit. If therefore the slit is on Rowland's circle, the spectrum will be formed on the same circle and one point of it will coincide with the slit (Fig. 1). The wave-length of the light which

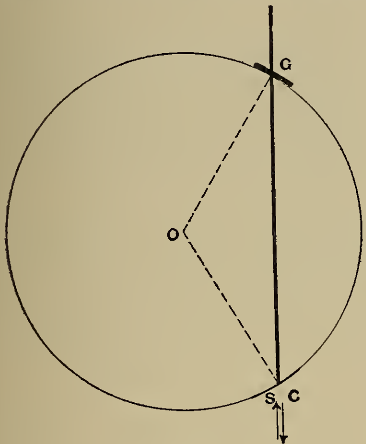


FIG. 1

is returned to the slit is given by the formula

$$\lambda = (2e/m) \sin \phi,$$

where e is the distance between consecutive rulings, ϕ the angle made by the light with the grating-normal, and m the order of the spectrum. It follows that at a given angle the order is twice that which is produced at the center of curvature.[2]

[1] Abstract of a paper read before the American Philosophical Society, April 20, 1912.

[2] The application of autocollimation to the concave grating was first described by A. Eagle, *Astrophys. Jour.*, 31, p. 120, 1910.

In this method, since the focal length changes in passing through the spectra, not only the inclination of the grating, but also its distance from the slit, must be altered. In addition the focal plane, which coincides with the arc of Rowland's circle, is inclined to the direction of the light by the same angle as the grating, and therefore the inclination of the camera must be changed to correspond with that of the grating. See Fig. 1, where G is the grating, S the slit, and the arc at C represents the position of the photographic plate in the camera.

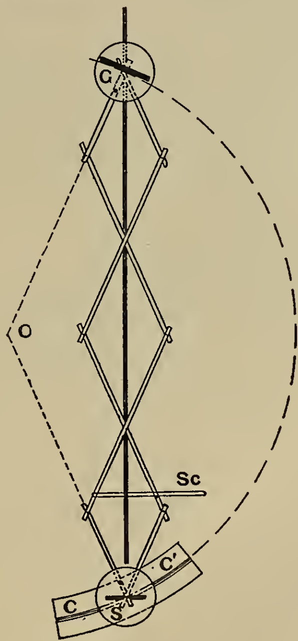


FIG. 2

In the instrument here described these adjustments are automatically made in the following manner. The grating is carried on a platform which slides along a horizontal track GS (Fig. 2) and is also capable of rotation about a vertical axis through its center. At one end of the track is a fixed vertical axis, carrying a platform S for the slit and another CC' for the camera, both capable of rotation. The two axes are joined by a system of link bars of the "lazy-tongs" type, the total length of which, when fully extended, is equal to ρ, the radius of the grating. It is obvious that when the inclination of the bars to the track is ϕ, the distance GS will be $\rho \cos \phi$. If then the first and last bars of the linkage on one side are connected to the camera and grating so as to be parallel respectively to their normals, the inclination of both camera and grating will be correct however the distance GS is altered. Since either side may be used, all the grating spectra become available.

The linkage is supported at its intersections by blocks which slide along the track. The grating slider is moved by a rod or screw running to the end of the track near the slit, the only function of the linkage being to produce the necessary rotation. There is therefore no great stress on the axes tending to bend them. The grating and slit are provided with the usual adjustments and also may be shifted on their platforms until their centers fall exactly in the axes of rotation. The camera is mounted on its platform on either side of the slit at C or C' or preferably just above it, and may be adjusted so as to bring the plate into coincidence with the focal circle. For visual observation the plateholder may be replaced by an eyepiece. The slit is made double so that light may be sent through one part and returned through the other. The apparatus is thus available for a threefold use, as a spectrograph, as an observing spectroscope, and as a monochromator.

The diagonal of any parallelogram of the linkage perpendicular to the track is proportional to sin ϕ, and therefore to the wave-length. A scale of equal parts placed across any part of the linkage perpendicular to the track, as Sc (Fig. 2), will, therefore, give an approximate measure of the wave-length. A more open scale may be placed on the track, but this will not be one of equal parts.

As everything is supported upon one track, the apparatus may be made quite rigid, and at the same time, with the smaller gratings at least, portable. It will take up much less space than the other mountings. It is also more convenient, as everything is in reach at the same time from the end of the track—source, slit, camera and handle for controlling the position of the grating. There is but one track to make true, and the other adjustments are no more difficult, and in some cases much easier, than in the Rowland mounting. A very desirable feature is that the slit, grating and camera may be connected by a light-proof bellows or other enclosure, so that the instrument may be used in an undarkened room. This bellows may be supported partly upon the blocks which carry the linkage.

The great compactness of the mounting makes it available for use in astronomical spectroscopy. The instrument may be mounted upon a telescope in the prolongation of its axis so that the slit lies in the focal plane of the objective. (In the case of a star image the slit could be dispensed with, and the astigmatism of the grating would produce a spectrum of finite width.) A more rigid and more convenient arrangement would be to mount the guides for the grating upon the tube of the telescope. The light could be brought to a focus by the objective at the side of the field nearest the slit and thrown upon the slit by totally reflecting prisms.

The definition of the spectrum is somewhat greater than with the usual mounting, when spectra of the same order are compared. Moreover twice as many orders on each side may be observed. The principal disadvantages are that the scale of the spectra is not constant, so that the spectra are not normal. The deviations, however, are quite small and may be accurately allowed for. Another objection is the inclination of the plate, which requires special care in its register. These objections, which are shared by prism spectrographs, are much less serious when comparison spectra are used on the same plate.

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SCIENCE

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MSS. intended for publication and books, etc., intended for review should be sent to the Editor of Science, Garrison-on-Hudson, N. Y.

DOCTORATES CONFERRED BY AMERICAN UNIVERSITIES

In the first five of the fifteen years during which records of the doctorates of philosophy conferred by our universities have been annually printed in Science, there was no increase in the number, the average being 233. In the course of the past ten years the number has about doubled, amounting this year to 492. The twenty-one German universities gave two years ago 1,703 doctorates of philosophy (of which 32 were to Americans), so we still fall far behind that country in the number of men adequately prepared for advanced teaching and research. As the population of the United States is half again as large as that of Germany, we must increase six-fold the number of doctorates conferred before we can reach the present level of that country.

The seven universities given at the beginning of the table conferred three fifths of all the degrees, but the other universities have gained somewhat, as for the first ten years covered by these statistics they conferred only one quarter of the degrees. The universities which have hitherto done less research work, and especially the state universities, are gaining somewhat on the older universities, with the exception of Columbia. This university has made a remarkable advance in the past two years, conferring this year 81 and last year 75 doctorates, thus drawing ahead of Chicago in the total number of degrees conferred in the past fifteen years. Yale and the Johns Hopkins remain about stationary in the number of degrees they confer, while Cornell, Pennsylvania and Harvard have

TABLE I

Doctorates Conferred

	Average of 10 Years, 1898–1907	1908	1909	1910	1911	1912	Total for 15 Years, 1898–1912
Columbia	32.2	55	59	44	75	81	636
Chicago	35.6	54	38	42	55	57	602
Harvard	33.8	42	38	35	42	41	536
Yale	31.8	32	44	27	31	31	483
Johns Hopkins	30.5	28	27	23	28	32	443
Pennsylvania	22.5	32	29	26	29	34	375
Cornell	18.1	22	34	35	34	33	339
Wisconsin	8.6	17	16	18	15	27	179
Clark	8.7	11	9	14	16	6	143
New York	6.7	15	13	11	17	10	133
Michigan	6.9	4	13	7	6	11	110
Boston	4.4	11	13	6	13	8	95
California	3.3	4	10	6	6	15	74
Princeton	2.6	6	4	8	9	12	65
Illinois	.5	5	4	12	11	20	57
Minnesota	2.4	3	5	1	2	12	47
Byrn Mawr	2.1	4	2	5	5	9	46
George Washington	2.8	3	4	4	5	2	46
Virginia	2.8	4	1	4	2	4	43
Brown	2.3	2	5	1	4	6	41
Catholic	2.0	1	3	3	5	5	37
Stanford	1.4	2	3	5	4	4	32
Nebraska	2.0	2	2	1	0	3	28
Iowa	1.1	2	0	4	3	7	27
Massachusetts Inst.	.3	3	0	3	2	6	17
Cincinnati	.3	0	2	2	5	3	15
Ohio	.4	0	2	0	2	5	13
Indiana	.0	3	3	0	2	4	12
Missouri	.4	3	0	2	2	1	12
Vanderbilt	.6	1	1	2	0	1	11
Washington	.7	1	0	0	2	1	11
Georgetown	1.0	0	0	0	0	0	10
Pittsburgh	.1	4	0	2	1	1	9
Kansas	.3	0	0	3	1	0	7
Syracuse	.2	0	2	1	2	0	7
Colorado	.5	0	1	0	0	0	6
North Carolina	.5	0	1	0	0	0	6
Northwestern	.4	0	1	0	1	0	6
Tufts	.5	0	0	1	0	0	6
Washington and Lee	.4	1	0	0	0	0	5
Lafayette	.3	0	0	0	0	0	3
Dartmouth	.1	1	0	0	0	0	2
Lehigh	.2	0	0	0	0	0	2
Tulane	.1	0	0	0	0	0	1
Total	272.4	378	389	358	437	492	4,778

increased their numbers and in this order. Wisconsin conferred this year 27 degrees, Illinois 20, California 15, Minnesota 12 and Iowa 7, this being in each case a large advance over the numbers conferred in any previous year. Princeton with 12 degrees and Bryn Mawr with 9 also demonstrate a decided growth in graduate work.

TABLE II

Doctorates Conferred in the Sciences

	Average of 10 Years, 1898–1907	1808	1909	1910	1911	1912	Total for 15 Years, 1898–1912	Per Cent.
Chicago	16.4	37	20	24	35	37	317	53
Johns Hopkins	16.8	17	20	15	19	23	262	59
Columbia	13.4	21	23	11	29	36	254	40
Cornell	10.4	15	24	27	27	28	225	66
Yale	12.4	16	27	12	15	21	215	45
Harvard	14.1	13	14	10	20	15	213	40
Pennsylvania	9.0	18	13	12	10	9	152	41
Clark	7.7	11	8	14	16	6	132	92
Wisconsin	2.8	6	4	13	13	14	78	44
California	2.4	2	6	4	5	12	53	72
Michigan	2.8	1	5	1	3	8	46	42
Illinois	.3	0	2	9	6	15	35	61
Princeton	1.1	3	3	2	5	7	31	48
George Washington	1.7	2	2	3	4	2	30	65
Brown	1.2	2	2	1	3	4	24	59
Stanford	1.1	2	2	1	4	3	23	72
Bryn Mawr	1.0	1	0	2	1	3	17	37
Massachusetts Inst.	.3	3	0	3	2	6	17	100
Nebraska	1.3	1	2	1	0	0	17	61
Virginia	1.1	2	0	1	1	2	17	40
Minnesota	.7	1	2	1	2	2	15	32
New York	.6	1	3	2	1	2	15	11
Iowa	.7	0	0	2	1	3	13	48
Ohio	.4	0	2	0	2	5	13	100
Indiana	.0	3	3	0	2	4	12	100
Washington	.7	1	0	0	2	1	11	100
Catholic	.5	–	2	0	1	1	9	24
Missouri	.3	2	0	2	2	0	9	75
Cincinnati	.1	0	1	1	4	1	8	53
Kansas	.3	0	0	3	1	0	7	100
Vanderbilt	.3	1	1	0	0	1	6	55
Tufts	.5	0	0	0	0	0	5	83
North Carolina	.3	0	1	0	0	0	4	67
Northwestern	.2	0	1	0	1	0	4	67
Washington and Lee	.3	1	0	0	0	0	4	80
Boston	.1	0	1	0	0	1	3	3
Pittsburgh	.0	0	0	1	1	1	3	33
Syracuse	.1	0	0	1	1	0	3	43
Colorado	.2	0	0	0	0	0	2	33
Dartmouth	.1	1	0	0	0	0	2	100
Lehigh	.2	0	0	0	0	0	2	100
Georgetown	.1	0	0	0	0	0	1	10
Lafayette	.1	0	0	0	0	0	1	33
Total	124.1	184	194	179	239	273	2,310	48

It is a fact of interest to readers of this journal that the number of degrees conferred in the natural and exact sciences increases more rapidly than in other subjects. During the ten years from 1898 to 1907 there were conferred an average of 124 degrees in the sciences as compared with 148 in other departments. In the following three years the numbers were almost exactly the same, whereas in the past two years the sciences have drawn ahead, being responsible this year for 273 degrees, as compared with 219 in other subjects. This advance is too large and too long continued to be attributable to a chance variation; it appears that the sciences are gaining ground in our universities. In Germany more degrees are conferred in the humanities than in the sciences, and the large number of degrees conferred there in the languages is striking. In this country there were this year only 17 degrees in Latin and 5 in Greek. Among the sciences, as always, chemistry leads and by a larger margin than ever before. This degree is in many cases awarded to men who propose to undertake industrial work; while this is doubtless quite as important as teaching, the degree has a somewhat different significance, so that it might indeed be advisable to award a doctorate of engineering rather than the doctorate of philosophy. Physics follows chemistry in the total number of degrees conferred, and is in turn followed by zoology, though there were this year more degrees awarded in botany, mathematics, geology and psychology than in zoology. Agriculture and bacteriology, as well as botany, show decided gains; there are also gains in physiology and anatomy.

The institutions which this year conferred two or more degrees in a science are: in *chemistry,* Columbia, 11; Johns Hopkins and Yale, 9 each; Chicago and Wisconsin, 8 each; Illinois, 6; Cornell, 5; Harvard and Ohio, 4 each; Massachusetts Institute, 3; Michigan and Princeton, 2 each; in *physics,* Cornell and Princeton, 4 each; Chicago, Illinois, Michigan, Pennsylvania and Yale, 3 each; Columbia, Johns Hopkins and Wisconsin, 2 each; in *zoology,* Harvard, 5; Cornell, 3; California and Chicago, 2 each; in *psychology,* Columbia, 8; Clark, 6; Pennsylvania, 4; Cornell, 3; Chicago and Johns Hopkins, 2 each; in *mathematics,* Chicago 7; Columbia, 4; Cali-

TABLE III

Doctorates Distributed According to Subjects

	Average of 10 Years, 1898–1907	1908	1909	1910	1911	1912	Total for 15 Years, 1898–1912
Chemistry	32.3	54	43	48	68	78	614
Physics	15.5	22	25	25	33	30	290
Zoology	15.2	25	18	24	25	20	264
Psychology	13.5	23	21	20	23	29	251
Mathematics	12.1	23	14	23	25	22	228
Botany	12.6	11	16	10	20	30	213
Geology	7.1	5	13	10	15	22	136
Physiology	4.1	7	13	4	2	12	79
Astronomy	3.4	1	7	3	4	2	51
Agriculture	1.0	2	7	4	11	11	45
Bacteriology	1.4	1	5	1	4	6	31
Anthropology	1.0	4	4	2	2	0	22
Paleontology	1.6	1	0	2	0	1	20
Anatomy	.9	2	0	1	1	6	19
Pathology	.5	2	3	1	1	2	14
Engineering	.8	0	0	1	2	2	13
Mineralogy	.6	0	3	0	1	0	10
Metallurgy	.3	0	1	0	1	0	5
Geography	.1	1	1	0	1	0	4
Meteorology	.1	0	0	0	0	0	1
Total	124.1	184	194	179	239	273	2,310

	1908	1909	1910	1911	1912	Total for 5 Years
English	30	27	31	33	34	155
History	32	22	25	26	23	128
Economics	17	42	7	16	26	108
Philosophy	25	14	19	26	15	99
Education	6	9	13	23	22	73
Latin	12	12	15	11	17	67
German	14	14	16	7	15	66
Romance	12	16	6	12	15	61
Sociology	6	6	14	18	13	57
Oriental	9	15	11	1	10	46
Greek	13	11	5	7	5	41
Political Science	9	4	9	6	10	38
Theology	7	2	1	7	7	24
Philology and Comparative Literature	0	1	5	1	2	9
Law	1	0	1	2	1	5
Classical Archeology	0	0	0	1	3	4
Music	1	0	1	1	0	3
Fine Arts	0	0	0	0	1	1
Total	194	195	179	198	219	985

fornia, Johns Hopkins and Yale, 2 each; in *botany*, Chicago, 8; Cornell, 4; Columbia, 3; California, Indiana, Iowa and Michigan, 2 each; in *geology*, Johns Hopkins, 5; Yale, 4; Massachusetts Institute, 3; Bryn Mawr and Columbia, 2 each; in *physiology*, California, 4; Columbia, 3; Chicago, 2; in *agriculture*, Cornell, 6; Illinois, 3; in *bacteriology*, Brown, 2; in *pathology*, Chicago, 2.

The names of those on whom the degree was conferred in the natural and exact sciences, with the subjects of their theses, are as follows:

UNIVERSITY OF CHICAGO

Warder Clyde Allee: "The Effect of Dissolved Gases on the Behavior of Isopods."

Harriett May Allyn: "A Contribution to the Analysis of Fertilization in *Chætopterus*."

Harold DeForest Arnold: "Limitations Imposed by Slip and Inertia Terms upon Stokes's Law for the Motion of Spheres through Liquids."

Melvin Amos Brannon: "The Action of Salton Sea Water on Plant Tissues."

Clyde Brooks: "The Effect of Lesions of the Dorsal Nerve on the Reflex Excitability of the Spinal Cord."

Edward Wilson Chittenden: "Infinite Developments and the Composition Property $(K_{12}B_1)_*$ in General Analysis."

Grace Lucretia Clapp: "The Life History of *Aneura pinguis*."

Harry John Corper: "Correlation of Chemical and Histological Changes in Necrosis and Autolysis."

Edmund Vincent Cowdry: "The Relations of Mitochondria and other Cytoplasmic Constituents in Spinal Ganglion Cells of the Pigeon."

Lloyd Lyne Dynes: "The Highest Common Factor of a System of Polynomials with an Application to Implicit Functions."

Sophia Hennion Eckerson: "A Physiological and Chemical Study of After-ripening."

Charles Albert Fischer: "Some Contributions to the Theory of Functions of Lines."

Laura Campbell Gano: "The Physiographic Ecology of Northern Florida."

Stella Mary Hague: "A Morphological Study of *Diospyros virginiana*."

Ansel Francis Hemenway: "The Phloem of Dicotyledons."

Ernest Edward Irons: "Studies on Immunity."

Fred Conrad Koch: "The Nature of the Iodine Complex in Thyreo-globulin."

Oliver Justin Lee: "On the Conditions for Reversal of the Calcium Lines."

Harvey Brace Lemon: "The Influence of Temperature upon the Intensities of the Lines of the Hydrogen Spectrum."

Theodore Lindquist: "Mathematics for Freshmen Students of Engineering."

Arno Benedict Luckhardt: "The Relation of the Spleen to the Fixation of Antigens and the Production of Immune Bodies."

Eugene Franklin McCampbell: "The Toxic and Antigenic Properties of *Bacterium welchii*."

Howard Wilson Moody: "A Determination of the Ratio of the Specific Heats and the Specific Heat at Constant Pressure of Air and Carbon Dioxide."

John Foote Norton: "Simultaneous Reactions in Amide Formation."

Paul David Potter: "The Hydrates of Arsenic Pentoxide."

Carl Leo Stahr Rahn: "A Critical and Constructive Study of the Psychology of Thinking."

Ralph Eugene Root: "Iterated Limits in General Analysis."

Lester Whyland Sharp: "Spermatogenesis in Equisetum."

Anna Morse Starr: "Comparative Anatomy of Dune Plants."

Charles Thompson Sullivan: "Properties of Surfaces whose Asymptotic Lines belong to Linear Complexes."

Arthur Carleton Trowbridge: "The Geology of the Owena Valley California Region with special Reference to the Terrestrial Deposits."

Harlan Leo Trumbull: "The Molecular Rearrangement of Acid Chloramides and the Ionization of their Salts."

Charles Herman Viol: "Studies in Radioactivity."

Leroy Samuel Weatherby: "The 'Salt Effects' of the Nitrates and Sulphonates in the Catalysis of Imido Esters."

Franklin Lorenzo West: "The Physical and Chemical Properties of Organic Amalgams."

Russell Morse Wilder: "The Etiology of Typhus Fever."

Albert Harris Wilson: "The Canonical Types of Nets of Quadratic Forms in the Galvis Field of Order p^n."

COLUMBIA UNIVERSITY

David Alperin: "Contribution to the Knowledge of Nucleoprotein Metabolism with special reference to Uricolysis and to the Properties of Uricase."

Tsuru Arai: "Mental Fatigue."

Charles Homer Bean: "The Curve of Forgetting."

Louis Edward Bisch: "Biochemical Studies of Protagon and Mucoid."

Jacob J. Bronfenbrenner: "A Biochemical Study of the Phenomenon known as Complement-splitting."

Arthur Jerome Culler: "Interference and Adaptability."

Bernard Ogilvie Dodge: "Methods of Culture and the Morphology of the Archicarp in certain Species of the Ascobolaceæ."

Harry Linn Fisher: "The Preparation and Properties of 5-Amino-6-Quinoline-Carboxylic Acid, and some Compounds derived therefrom."

Alexander Oscar Gettler: "The Balance of Acid-forming and Base-forming Elements in Foods, and its Relation to Ammonia Metabolism."

Alfred Norton Goldsmith: "On the Spectroscopic Examination of Positive Rays isolated by Transmission through thin Partitions."

Marston Lovell Hamlin: "I. The Preparation of two Derivatives of Glucosamine. II. Spigeline, an Alkaloid of *Spigelia marilandica*. III. Derivatives of 4-Hydroxy-5-Nitro-Quinazoline."

Raleigh Frederick Hare: "A Study of the Chemistry of the Carbohydrates of the Prickly Pear and its Fruits."

John Diederich Haseman: "Some Factors of Geographical Distribution in South America."

Milo Burdette Hillegas: "A Scale for the Measurement of Quality in English Composition by Young People."

Jesse Earl Hyde: "The Waverly Formations of Central and Southern Ohio."

Max Kahn: "Biochemical Studies of Sulfocyanates."

John Leonard Kantor: "A Biochemical Test for Free Acid."

Joseph Lipke: "Natural Families of Curves in a General Curved Space of n Dimensions."

Henry Howard Marvin: "The Selective Transmission and the Dispersion of the Liquid Chlorides."

Chester Arthur Mathewson: "A Study of some of the more Important Biochemical Tests."

Julia Eleanor Moody: "Observations on the Life-history of two Rare Ciliates—*Spathidium spathula* and *Actinobolus radians*."

Fayette T. Owen: "Part I. Molten Hydrated Salts as Solvents for Freezing Point Method. Part II. The Weight of the Falling Drop and the Laws of Tate."

Albert Theodore Poffenberger, Jr.: "Reaction Time to Retinal Stimulation; with reference to the Speed of Conduction through Nerve Centers."

David Edgar Rice: "Visual Acuity with Lights of Different Colors and Intensities."

Winifred Josephine Robinson: "A Taxonomic Study of the Pteridophyta of the Hawaiian Islands."

Emily Cromwell Seaman: "Biochemical Studies of the Effects of Beryllium Sulfate."

Lewis Parker Siceloff: "Simple Groups from Order 2001 to order 3640."

Benjamin Roy Simpson: "Correlation of Mental Abilities."

Bertram Garner Smith: "The Embryology of *Cryptobranchus allegheniensis*."

William Mackey Smith: "Simply Infinite Systems of Plane Curves. A Study of Isogonals, Equitangentials and other Families of Trajectories."

Charles Arthur Stewart: "The Geology and Ore-deposits of the Silverbell Mining District, Arizona."

Frederick Tilney: "Contribution to the Study of the Hypophysis Cerebri, with special reference to its Comparative Histology."

John Welhoff Todd: "Reaction to Multiple Stimuli."

Edward Everett Whitford: "The Pell Equation."

Harold Edward Woodward: "A Study of Surface Tension of Blood Serum by the Drop Weight Method."

Frederick William Zons: "A new Method, Volumetric, for the Determination of Thorium in the Presence of other Rare Earths and its Application to the Analysis of Monozite Sand."

CORNELL UNIVERSITY

Herman Camp Allen: "The Reduction of Nitrobenzene by Means of Ferrous Hydroxide."

Ross Peter Anderson: "Researches on Tellurium."

Mortier Franklin Barrus: "The Bean Anthracnose."

Henry Louis Brakel: "The Effect of Vibration on the Resistance of Metals."

Stanley Eugene Brasefield: "A Study of certain Force Fields."

Harry Oliver Buckman: "Optimum and Excessive Soil Moisture in its Effect upon the Soil and the Crop."

Lewis Josephus Cross: "A Study of the Relation of the Chemical Composition of Hens' Eggs to the Vitality of the Young Chick."

Lucy May Day: "The Effect of Illumination on Peripheral Vision."

Austin Southwick Edwards: "An Experimental Study of Suggestion."

Robert James Evans: "Studies in the Variation of *Stellaria media* as induced by Temperature Exposures."

Earl Frederick Farnau: "Luminescence."

Alexander Hardie Forman: "The Effect of Magnetization on the Opacity of Iron to Röntgen Rays."

Sidney Longman Galpin: "Studies of Flint Clays and their Associates."

Charles Cleveland Hedges: "Some Chemical Relations of Lime-sulphur Solutions, Lead Arsenate and Nicotine."

Emmet Francis Hitch: "Tetrachlorfluorescein and some of its Derivatives."

James Franklin Illingworth: "A Study of the Biology of the Apple Maggot (*Rhagoletis pomonella*) together with an Investigation of the Methods of Control."

Christian Nephi Jensen: "Fungous Flora of the Soil."

Clyde Everett Leighty: "Studies of Variation and Correlation of Oats (*Avena sativa*)."

Merris Mickey McCool: "The Antitoxic Action of certain Nutrient and Non-nutrient Mineral Bases with respect to Plants."

Anna Haven Morgan: "The Biology of Mayflies."

Frank Millett Morgan: "Involutorial Transformations."

Clyde Hadley Myers: "Variation, Correlation and Inheritance of Characters of Wheat and Peas grown on Soils of different Degrees of Fertility."

Irving Perrine: "The Claiborne Pelecypod Fauna of the Gulf Province."

Harry Westfall Redfield: "A Study of Hydrogen Sulphide Production by Bacteria and its Significance in the Sanitary Examination of Water."

George Jackman Sargent: "Electrolytic Chromium."

Alma de Vries Schaub: "On the Intensity of Images."

John Edwin Turlington: "The Effect on Plant Growth of Nutrients applied at different Periods."

Rhett Youmans Winters: "The Inheritance of Size of Capsules in Pepper Hybrids."

JOHNS HOPKINS UNIVERSITY

Raymond Binford: "The Germ-cells and the Process of Fertilization in the Crab *Menippe mercenaria*."

Thomas Ross Brown: "A Consideration of the Continued Fevers in the Tropics."

Joseph Chandler: "On the Reactions of Thiourazoles and Thiourazole Salts: I. A Study of the Reaction between Sodium 1-Phenyl-3-Thiourazole and Ethyl Iodide. II. A Study of 1, 4-Diphenyl-5-Thiourazole."

Burton William Clark: "The Trenton Limestone at Rathbone Brook, Herkimer County, New York—Its Stratigraphy, Fauna and Age."

Charles Wythe Cooke: "The Greenbrier Formation in Maryland. A Contribution to Mississippian Paleontology."

Paul Bell Davis: "Conductivity and Negative Viscosity Coefficients of certain Rubidium and Ammonium Salts in Glycerol, and in Mixtures of Glycerol with Water from 25° to 75°."

Felton Samuel Dengler: "I. The Detection and Determination of Minute Quantities of Glycerol. II. The Volumes of Weight-normal Cane Sugar Solutions at Different Temperatures."

Henry Otto Eyssell: "I. The Detection of Mannite in Alkaline Solutions of Copper Sulphate. Combustion of Mannite by Alkaline Solutions of Potassium Permanganate in the Presence of Copper Sulphate. II. A Determination of the Volume of Weight-normal Solutions of Cane Sugar at 15°, 20°, 25° and 30°."

Julia Peachy Harrison: "On the Reversible Addition of Alcohols to Nitriles catalyzed by Sodium Ethylate."

Clarence Wilson Hewlett: "Analysis of Complex Sound Waves."

Oliver Baker Hopkins: "The Carboniferous Sphenophyllales, Equisetales and Lycopodiales of Maryland, including certain Forms from Pennsylvania and Ohio."

Samuel Francis Howard: "The Conductivity, Temperature Coefficients of Conductivity and Dissociation of certain Electrolytes in Aqueous Solution at 35°, 50° and 65°."

John Frederick Hunter: "A Study of the Pre-Cambrian Rocks of the Gunnison River."

Harry Miles Johnson: "Some Tests on the Reactions of Dogs to Stimuli, under Conditions of Sensory Control."

Willis Edgar Maneval: "The Development of *Magnolia* and *Liriodendron*, including a Discussion of the Primitiveness of the Magnoliaceæ."

Charles Ferdinand Meyer: "On the Vibration of Telephone Diaphragms."

John William Nowell: "A Study of the Steric Hindrance Effect of various Substituent Groups in the Ortho Position to the Carboxyl; on the Reaction which takes Place when Parasulphaminobenzoic Acids are heated to 220°."

Alfred Springer, Jr.: "A Study of the Conductivity and Dissociation of certain Organic Acids in Aqueous Solution at different Temperatures."

Joshua Irving Tracey: "Researches on the Rational Quintic."

Lloyd Van Doren: "A Comparative Study of the Semi-permeable Membranes of Copper Ferrocyanide and Nickel Ferrocyanide."

George Ross Maurice Wells: "The Influence of Stimulus-duration on Reaction Time."

Richard Claggett Williams: "The Shenandoah Limestones of the Hagerstown Quadrangle."

Roy Martin Winger: "On Self-projective Rational Curves of the Fourth and Fifth Order."

YALE UNIVERSITY

William Raymond Barss: "Ionization by Collision in Gases and Vapors."

Philip Lee Blumenthal: "The Separation and Estimation of Chlorine and Bromine in Halogen Salts by the Differential Action of Oxidizers."

Charles Andrew Brautlecht: "Synthesis of Thiotyrosine."

Gerald Burnham: "Sulphur Combinations in Proteins-thiopolypeptides."

Amy Louise Daniels: "Fat-transport and Metabolism, Studied with the Aid of Fat-soluble Dyes."

Archibald Lamont Daniels, Jr.: "On the Librations of Bodies whose Periods are One Third that of the Disturbing Body."

Charles Raymond Downs: "Water-gas Tar: its Composition and Commercial Possibilities."

Charles Wales Drysdale: "The Geology of the Franklin Mining District, British Columbia."

Marion Graham Elkins: "The Maturation Phases in *Smilax herbacea*."

Herbert Hartley Guest: "Thiohydantoins and their Biochemical Interest."

Frank Loyal Haigh: "On certain Physical Properties of the Alkali Nitrates, Chlorides and Sulphates."

Charles Hoffman: "A New Method for Synthesizing Alpha-amino Acids; Halogen Derivatives of Tyrosine."

Davenport Hooker: "The Development and Function of Voluntary and Cardiac Muscles in Embryos without Nerves."

Robert Curtis Lewis: "The Rate of Elimination of Nitrogen as influenced by Diet Factors."

Alexander Graham McGougan: "The Emission of Electrons by Metals under the Influence of Alpha Rays."

John Johnston O'Neill: "Geology and Petrography of the Beloeil and Rougemont Mountains, Quebec."

Samuel James Plimpton: "On the Recombination of Ions produced by Röntgen Rays."

William Henry Twenhofel: "Geology, Stratigraphy and Physiography of Anticosti Island."

Harley Richard Willard: "On a Family of Oscillating Orbits of Short Period (with a chart)."

Merton Yarwood Williams: "Geology of the Arisaig-Antigonish District, Nova Scotia."

Morley Evans Wilson: "Preliminary Memoir on the Abitibi District, Pontiac County, Quebec."

HARVARD UNIVERSITY

Roger Adams: "I. A Study of the Solubilities in Aqueous Alkalis of various Hydrazones of certain Aromatic Ortho-hydroxyaldehydes and Ketones. II. Nonanes. III. A New Bottling Apparatus."

John Detlefsen: "A Genetic Study of Color and Coat Characters, and Growth and Size in a Cavy Species Cross."

Arthur Johnson Eames: "The Morphology of *Agathis australis* (Lamb.) Steud."

Gustavus John Esselen, Jr.: "Studies on Benzhydrols. I. The Resolution of p-Aminobenzhydrol into its Optical Isomers. II. The Splitting of Benzhydrols by the Action of Bromine."

Augustus Henry Fiske: "I. On certain Nitro Derivatives of Vicinal Tribrombenzol. II. Decomposition of Tetrabromorthoquinone. III. Hydrates of Sodium Carbonate and their Temperatures of Transition."

Fred Ford Flanders: "The Determination and Metabolism of Benzoic Acid and Hippuric Acid."

Tomlinson Fort: "Problems connected with Linear Difference Equations of the Second Order with special Reference to Equations with Periodic Coefficients."

Alfred Otto Gross: "The Reactions of Arthropods to Monochromatic Lights of Equal Intensities."

Franklin Paradise Johnson: "The Development of the Mucosa of the Digestive Tube in the Human Embryo, with notes on the Effects of Distention of the Intestine upon the Shape of Villi and Glands."

Sidney Isaac Kornhauser: "A Comparative Study of the Chromosomes in the Spermatogenesis of *Enchenopa binotata* (Say) and *Enchenopa* (*Campylenchia* Stål) *curvata* (Fabr.)."

Edwin Carleton MacDowell: "Size Inheritance in Rabbits."

Samuel Copeland Palmer: "The Numerical Relations of the Histological Elements in the Vertebrate Retina."

Eugene Lyman Porter: "Conditions affecting the Liminal Electrical Stimulus of a Spinal Reflex."

John Edward Rouse: "The Mental Life of Domestic Pigeons: An Experimental Study of certain Emotional and Associative Processes."

George Defrees Shepardson: "The Equivalent Frequency of Telephone Circuits.

UNIVERSITY OF ILLINOIS

Samuel Herbert Anderson: "Ionization of Photo-electric Properties of Vapors of Alkali Metals."

Stuart Jeffery Bates: "The Iodine Coulometer and the Value of the Faraday."

Charley Francis Briscoe: "Tubercle Bacilli in Nature."

David William Cornelius: "The Study of the Velocity of Electrons in the Photo-electric Effect as a Function of the Wave-lengths of the Light."

William Wells Denton: "Projective Differential Geometry of Developable Surfaces."

James Everett Egan: "Observations on the Rare Earths. Yttrium Chloride and the Atomic Weight of Yttrium."

Hugh Byron Gordon: "A Differential Dynamic Method for the Accurate Determination of Relative Vapor-pressure Lowering."

Walter Edward Joseph: "A Study of Protein as a Factor in the Nutrition of Swine with special reference to the Distribution of the various Forms of Nitrogen in the Animal Body."

Jacob Garrett Kemp: "Conditions of Sensibility of Photo-electric Cells with Alkali Metals and Hydrogen."

Leonidas Rosser Littleton: "Molecular Rearrangements in the Camphor Series. Derivatives of Isocamphoric Acid; Isoaminolauronic Acid and its Decomposition Products."

Ellison Lloyd Ross: "Phosphorus Metabolism of Lambs."

Earle Kenneth Strachan: "The Equilibrium between Arsenious Acid and Iodine in Aqueous Solution."

Maurice Cole Tanquary: "Biological and Embryological Studies on Formicidæ."

Albert Lemuel Whiting: "A Biochemical Study of Nitrogen in certain Legumes."

Richard Hermon Williams: "A Study of Protein as a Factor in the Nutrition of Swine, with special reference to the Distribution of the Forms of Ash and Phosphorus in the Animal Body."

UNIVERSITY OF WISCONSIN

Martin Fuller Angell: "Thermal Conductivity of Metals at High Temperatures."

Freda Marie Bachman: "A Cytological Study of *Collema*."

Oscar Leonard Barneby: "Reactions of the Rare Earths in Non-aqueous Solvents."

Frederick William Cunningham: "A Study of Fume Settling."

Horace Grove Deming: "Some Compounds of Cellulose."

Melvin Edison Diemer: "A Study of Aurous Compounds."

Emil Oscar Ellingson: "On Abietic Acid and some of its Salts."

Robert Harvie: "Ontario Gabbros and Associated Ores."

Winfield Scott Hubbard: "Studies of the Tryptic Digestion of Silk."

Alfred Edward Koenig: "A Study of some of the Salts of Fatty Acids."

James Nelson Lawrence: "Efficiency of Gas Calorimeters."

George Vest McCauley: "The Distribution of Energy in the Spectra of Metals."

Warner Jackson Morse: "Comparative Studies of the Bacteria associated with the Blackleg Disease of Potatoes."

Carl Ferdinand Nelson: "Studies on Osmosis."

UNIVERSITY OF CALIFORNIA

Charles Barrows Bennett: "The Purines of Muscle."

Victor Birckner: "The Oxidations and Cleavages of Glucose: Yeast Glucase, a new Glucolytic Ferment."

Lyman Luther Daines: "The Comparative Development of the Cystocarps of Antithamnion and Prionitis."

Jay Clinton Elder: "The Relation of the Zona Pellucida to the Formation of the Fertilization Membrane in the Egg of the Sea Urchin (*Strongylocentrotus purpuratus*)."

Thomas Harper Goodspeed: "Quantitative Studies of Inheritance in *Nicotiana* Hybrids."

Myrtle Elizabeth Johnson: "The Control of Pigment Formation in Amphibian Larvæ."

Walter Pearson Kelley: "The Functions and Distribution of Manganese in Plants and Soils."

Charles Gustave Paul Kuschke: "The Abelian Equations of the 10th Degree, irreducible in a given Rational Domain."

Loye Holmes Miller: "Contributions to Avian Paleontology from the Pacific Coast Region of North America."

Edward Haslam Walters: "The Hydrolysis of Casein by Trypsin."

Baldwin Munger Woods: "A Discussion by Synthetic Methods of two Projective Pencils of Conics."

Reynold Young: "The Polarization of the Light in the Solar Corona."

UNIVERSITY OF PENNSYLVANIA

Newcomb Kinney Chaney: "The Electrolytic Preparation of Antimony."

Ralph Winfred Duncan: "The Optical Constants of Sodium and Potassium."

Robert Carithers Duncan: "The Optical Constants of Sodium and Potassium."

Engelhardt August Eckhardt: "The Optical Constants of Solid Solutions."

Samuel Weiller Fernberger: "On the Methods of Just Perceptible Differences and Constant Stimuli."

Joseph Madison McCallie: "Standardization of some of the Common Tests used in testing the Acuteness of the Vision of School Children."

Francis Norton Maxfield: "An Experiment in Linear Space Perception: A Psychophysical Study of Sensitivity in the Discrimination of Small Differences in Lines about Two Inches Long."

Reuel Hull Sylvester: "The Form Board Test."

Edward Embree Wildman: "The Spermatogenesis of *Ascaris megalocephala*, with special reference to the Two Cytoplasmic Inclusions, the Refractive Body and the 'Mitochondria'; Their Origin, Nature and Rôle in Fertilization."

UNIVERSITY OF MICHIGAN

Harvey Clayton Brill: "A Study of the Formation of Pyrimidines by use of Nitromalonic Aldehyde."

Henry Newell Goddard: "Can Soil Fungi Assimilate Atmospheric Nitrogen?"

Clarence W. Greene: "Polarization in the Aluminium Rectifier, with special reference to the Development of a Potentiometer Method of determining the Decay of the Counter Electromotive Force of Polarization."

James Elmer Harris: "The Elastic Properties of Bismuth Wires."

Irving Day Scott: "The Spacing of Fracture Systems and its Influence on the Relief of the Land."

Clarence Jay West: "The Salts of the Oxy Xanthenols (A Contribution to the Chemistry of Quino Carbonium Salts)."

Neil Hooker Williams: "Stability of Remanent Magnetism."

Elizabeth Dorothy Wuist: "The Morpho-physiological Life History of the Gametophyte of *Onoclea struthiopteris*."

PRINCETON UNIVERSITY

Garrett Davis Buckner: "Studies on the Silver Coulometer."

Karl Taylor Compton: "Studies in the Photoelectric Effect."

Claude William Heaps: "The Effect of Magnetic Fields on the Resistance of Metals and Conducting Crystals."

Otto Frederic Kampmeier: "The Development of the Thoracic Duct in the Pig."

Joseph Stanley Laird: "A Study of the Inclusions in Electrolytic Silver, and their Effect on the Electrochemical Equivalent of Silver and the Electrochemical Equivalent of Cadmium."

Charles Sheard: "The Ionization Produced by Hot Salts and by Freshly Heated Metal Wires."

Phillips Thomas: "A Study of the Action of Dielectrics under Applied Alternating Electric Stresses, with regard to the Loss of Energy which occurs."

CLARK UNIVERSITY

Eugene William Bohannon: "Exceptional Children and the Only Child in the Family."

John Madison Fletcher: "An Experimental Study of some of the Incoordinations of Functional Speech Disturbances."

Frank Eugene Howard: "The Pedagogy of the Emotions."

Karl Johan Karlson: "Psychoanalysis and Mythology."

John Milton McIndoo: "Instinct as related to Education."

Tadaichi Ueda: "The Psychology of Justice."

MASSACHUSETTS INSTITUTE OF TECHNOLOGY

John Andrew Allan: "Geology of the Ice River District, British Columbia."

Norman Levi Bowen: "The Binary System: $Na_2Al_2Si_2O_8$ (Nephelite, Carnegieite) $CaAl_2Si_2O_8$ (Anorthite)."

Arthur Edgar: "The Equilibrium between Nitric Acid, Nitric Oxide and Nitrous Acid."

Merle Randall: "Studies in Free Energy."

Frank Finch Rupert: "The Free Energy of Concentrated Solutions."

Stuart James Schofield: "Geology of East Kootenay, British Columbia, with special reference to the Origin of Granite in Sills."

OHIO STATE UNIVERSITY

Cecil Ernest Boord: "The Action of Substituted Hydrazones upon Orthoquinones—a Contribution to a Study of the Constitution of Orthohydroxyazo Compounds."

Freda Detmers: "An Ecological Study of Buckeye Lake—a Contribution to the Phytogeography of Ohio."

David Raymond Kellogg: "The Hydrolysis of Ethyl Acetate by Neutral Salt Solutions."

George Weatherworth Stratton: "The Action of Substituted Tolyl Hydrazines upon Quinones."

Edgar John Witzemann: "Oxidation of Propylene Glycol."

BROWN UNIVERSITY

William Ward Browne: "Acid Production by the *Bacillus coli* Group."

John Wymond Miller Bunker: "Colon Bacilli in Polluted Oysters."

Robert Foster Chambers: "A Study of Symmetrical Tribrom Phenyl Propiolic Acid."

Walter Edward Sullivan: "*Pseudopleuronectes americanus.*"

INDIANA UNIVERSITY

Caroline Anna Black: "The Morphology of *Riccia frostii* Aust."

Mary Theresa Harman: "Method of Cell Division in the Sex Cells of *Tænia teniæformis.*"

Cora Barbara Hennel: "Certain Transformations and Invariants connected with Difference Equations and other Functional Equations."

William Logan Woodburn: "Spermatogenesis in certain Hepaticæ."

BRYN MAWR COLLEGE

Eleanora Frances Bliss: "Crystalline Rocks of the Doe Run Region, Pennsylvania."

Minnie Almira Graham: "A Study of the Change from Violet to Green in solutions of Chromium Sulphate."

Anna Isabel Jonas: "The Geology of the Avondale District, a Key to the Relations of the Wissahickon Mica-gneiss and the Shenandoah Limestone of the Piedmont of Pennsylvania."

UNIVERSITY OF IOWA

James Ellis Gow: "Embroyology of the Aroids."

Fred Jay Seaver: "The Hypocreales of North America."

Franklin Orion Smith: "The Effect of Training in Tonal Hearing."

STANFORD UNIVERSITY

Charles Victor Burke: "A Biological and Taxonomic Study of the Cyclogasteridæ."

John Edgar Coover: "Formal Discipline from the Standpoint of Experimental Psychology."

Hally Delilia Mary Jolivette: "Studies on the Reaction of *Pilobolus* to Light Stimuli."

GEORGE WASHINGTON UNIVERSITY

A. L. Kibler: "Mercury Fulminate."

W. J. McCaughey: "Mineralogical Methods in Soil Investigation."

UNIVERSITY OF MINNESOTA

Francis Cowles Frary: "Equilibria in Systems containing Alcohols, Salts and Water, including a New Method of Alcohol Analysis."

Charles Eugene Johnson: "The Development of the Prootic Head Somites and Eye Muscles of *Chelydra serpentina.*"

NEW YORK UNIVERSITY

Ephraim M. Ewing: "The Venous Pulse."

Albert B. Pacini: "Metamorphism in Portland Cement."

UNIVERSITY OF VIRGINIA

George Frederic Paddock: "Some Adaptations and Criticisms of Spectroscopic Orbit Formulæ with an Application to V 4 Eridani, A. G. C. 4821x."

Stephen Taber: "Geology of the Gold Belt in the James River Basin, Virginia."

BOSTON UNIVERSITY

Robert E. Bruce: "Latitude Determination."

CATHOLIC UNIVERSITY OF AMERICA

Ignatius Albert Wagner: "The Condensation of Acetone by Means of Calcium Carbide."

UNIVERSITY OF CINCINNATI

Frances Kohnky: "The Subjective Element in Mysticism."

UNIVERSITY OF PITTSBURGH

Harry Nelson Eaton: "Geology of South Mountain and the Reading Hills, Pennsylvania."

VANDERBILT UNIVERSITY

Ernest Victor Jones: "A Spectrographic Study of Tellurium."

WASHINGTON UNIVERSITY

Charles Haskell Danforth: "The Anatomy of *Polyodon*."

THE CELEBRATION OF THE TWO HUNDREDTH ANNIVERSARY OF THE ROYAL SOCIETY

The celebration of the two hundred and fiftieth anniversary of the founding of the Royal Society of London began on Monday, July 15, when the president and the fellows received their guests informally in the rooms of the society at Burlington House. The first formal recognition of the anniversary, apart from the visit of the president and the treasurer to the king to present to him the memorial volumes on Saturday, was at noon on Tuesday at Westminster Abbey, when a special service was held. The dean of Westminster preached the sermon, taking his text from Esdras, "Truth abounds and is strong for ever." The formal reception of the delegates took place in the afternoon at Burlington House. After formally giving the delegates welcome, Sir Archibald Geikie, the president, made an address in which he traced the origin and early days of the society.

The ceremony of presenting addresses of congratulation followed. Besides the formal addresses, there were speeches by a representative of each country or dominion. The selected speakers were:

Austria-Hungary—Professor Izidor Fröhlich, rector of the Royal Hungarian University, Budapest.

Belgium—Professor Louis Dallo, Académie Royale des Sciences, Brussels.

Denmark—Professor Hector F. E. Jurgensen, University of Copenhagen.

France—M. Gabriel Lippmann, president of the Académie des Sciences de l'Institut, Paris.

Germany—Professor Dr. Woldemar Voigt, rector of the University of Göttingen.

Greece—Professor Andrew Andreades, University of Athens.

Italy—Professor Vito Volterra, University of Rome.

Monaco—Mr. J. Y. Buchanan, F.R.S., Oceanographical Institute.

Netherlands—Professor P. Zeeman, secretary of the Academy of Sciences, Amsterdam.

Norway—Professor H. Mohn, president of the Academy of Sciences of Christiania.

Russia—Dr. O. Backlund, Acad. Impériale des Sciences, St. Petersburg.

Spain—Professor Rodriguez Carracido, Real Acad. de Ciencias, Madrid.

Sweden—Count K. A. H. Mörner, vice-president, Kongliga Svenska Vetenskaps Akademie, Stockholm.

Switzerland—Professor E. Naville, University of Geneva.

Egypt—Dr. James Currie, principal of the Gordon College, Khartum.

Japan—Professor R. Fujisawa, Imperial University, Tokyo.

United States—Professor W. B. Scott, vice-president American Philosophical Society, Philadelphia.

Australia—Professor H. Laurie, University of Melbourne.

Canada—Dr. W. Peterson, principal, McGill University, Toronto.

India—Dr. F. G. Selby, late vice-chancellor, University of Bombay.

South Africa—Sir David Gill, F.R.S., Royal Society of South Africa.

England and Wales—Dr. C. B. Heberden, vice-chancellor of Oxford (universities), and Sir C. H. Read, president, London Society of Antiquaries (learned societies).

Scotland—The Very Rev. Dr. G. Adam Smith, principal of the University of Aberdeen.

Ireland—Professor J. Joly, F.R.S., University of Dublin (Trinity College).

On Tuesday evening a banquet took place at the Guild-hall. Sir Archibald Geikie was in the chair and the principal addresses were made by Mr. Asquith, the prime minister, and Lord Morley. On Wednesday the Duke and Duchess of Northumberland gave a garden party to the delegates at Syon House, and in the evening a conversazione was held at Burlington House. On Thursday the king, the patron of the society, and the queen, received the president and council and the delegates at Windsor, and on the same afternoon the fellows attending the celebrations were at a garden party at Windsor, the royal reception concluding the celebration.

Among some 200 delegates the following were from the United States and Canada:

University of California, Professor H. C. Plummer; University of Chicago, Professor E. B. Frost; Clark University, Worcester, Professor A. G. Webster; Columbia University, New York, Dr. N. M. Butler (president); Cornell University, Ithaca, N. Y., Professor J. H. Comstock; Harvard University, Professor B. O. Peirce; Johns Hopkins University, Baltimore, Professor W. B. Clark; Leland Stanford Junior University, California, Professor V. L. Kellogg; University of Michigan, Professor W. H. Hobbs; University of Minnesota, Minneapolis, Dr. A. Hamilton; University of Pennsylvania, Philadelphia, Dr. E. F. Smith (provost); Princeton University, New Jersey, Professor J. G. Hibben (president); University of Wisconsin, Professor C. K. Leith; Yale University, Dr. A. T. Hadley (president); American Academy of Sciences, Boston, Professor E. H. Hall; Connecticut Academy of Arts and Sciences, Professor E. W. Brown, F.R.S.; American Mathematical Society, New York, Professor H. B. Fine (president); American Philosophical Society, Philadelphia, Professor W. B. Scott (vice-president); Franklin Institute, Philadelphia, Major G. O. Squier; California Academy of Sciences, San Francisco, Mr. J. D. Grant; Carnegie Institution, Washington, Dr. R. S. Woodward (president); National Academy of Sciences, Washington, Dr. A. Hague (secretary); Smithsonian Institution, Washington, Dr. A. Hague; Washington Academy of Sciences, Dr. L. O. Howard; McGill University, Montreal, Dr. W. Peterson (principal); University of Toronto, Mr. R. A. Falconer (president); Queen's University, Kingston, Ontario, Professor J. Watson; University of New Brunswick, Fredericton, N. B., Dr. C. C. Jones (chancellor); University of Manitoba, Winnipeg, Professor S. Vincent; University of Ottawa, Rev. Dr. Roy (rector); Royal Society of Canada, Ottawa, Sir Gilbert Parker, M.P.; Nova Scotian Institute of Science, Halifax, N. S., Professor J. G. MacGregor, F.R.S.

PAUL CASPAR FREER

The members of the Bureau of Science of the Government of the Philippine Islands have passed the following resolutions:

Whereas it has pleased Almighty God in His wise and inscrutable providence to remove from our midst Paul Caspar Freer, M.D., Ph.D., director of the Bureau of Science of the government of the Philippine Islands, since the time of its organization as the Bureau of Government Laboratories in the year 1901, dean of the College of Medicine and Surgery, and professor of chemistry, University of the Philippines, and founder and editor-in-chief of the *Philippine Journal of Science*, who, for many years, has been our leader, counselor and friend, and

Whereas at best we can do little to indicate at this time our real appreciation of him as a man and as a worker for the general good, therefore be it

Resolved, that we, the members of the staff of the Bureau of Science in Manila, Philippine Islands, do hereby express our deepest sorrow and keen feeling of personal loss in the death of Dr. Freer, and be it further

Resolved, that he holds a place of highest respect, admiration and appreciation both officially and personally in the hearts of all of us, and especially of those who were most intimately associated with him in scientific work, and be it further

Resolved, that it is the sense of the members of this institution that the Bureau of Science has suffered a very great loss and that the cause of science in these islands has been deprived of one of its most zealous and conscientious advocates, and be it further

Resolved, that we extend our sincere sympathy and condolence to his widow in her overwhelming grief, to his brother and other relatives, and be it further

Resolved, that copies of these resolutions be engrossed and sent to the bereaved widow and brother of Dr. Freer, and that they be filed in the archives of the Bureau of Science, transmitted to the Bureau of Civil Service, published in the forthcoming number of each section of the *Philippine Journal of Science*, in the newspapers of Manila, in a paper in the city of Chicago, Dr. Freer's birth-place, and in Science, the official organ of the American Association for the Advancement of Science, of which Dr. Freer was a fellow.

For the staff of the Bureau of Science,

Richard P. Strong
Charles S. Banks
E. D. Merrill
Alvin J. Cox
Oscar Teague
A. E. Southard
Committee

At Manila, Philippine Islands, this Eighteenth Day of April, in the Year of Our Lord One Thousand, Nine Hundred and Twelve.

SCIENTIFIC NOTES AND NEWS

A committee representing the engineering societies of the British Empire and the United States of America has been formed to carry into effect a proposal for the erection in Westminster Abbey of a memorial window to the late Lord Kelvin.

As already noted in Science Cambridge University has conferred its doctorate of science on Professor E. B. Frost, director of the Yerkes Observatory. At the same time the degree was conferred on the following foreign men of science attending the two hundred and fiftieth anniversary of the Royal Society: the Marchese Emanuele Paternò di Sessa, professor of chemistry in the University of Rome; Professor Pavlov, St. Petersburg University; Professor Picard, University of Paris; Professor Rubens, University of Berlin, and Dr. Warming, formerly professor of botany at Copenhagen.

On the occasion of the bicentenary celebration of the Trinity College Medical School, Dublin, the degree of doctor of science was conferred on a number of delegates, including Dr. J. George Adami, professor of pathology and bacteriology, McGill University; Dr. Franklin P. Mall, professor of anatomy at the Johns Hopkins University; Dr. Edgar F. Smith, provost of the University of Pennsylvania, and Dr. J. Whitridge Williams, professor of obstetrics at the Johns Hopkins University.

The University of Vermont has conferred the degree of doctor of science on Professor Edward H. Williams, Jr., for many years professor of mining and geology at Lehigh University.

Dr. Henryk Arctowski, chief of the science department of the New York Public Library, was given the honorary degree of doctor of philosophy of the University of Lemberg on the occasion of its two hundred and fiftieth anniversary on May 29.

The University of Giessen has conferred the honorary degree of doctor of medicine on Mr. E. Leitz, Jr., head of the firm of Ernst Leitz, for his contributions to the advancement of microscopy and the construction of optical instruments.

Professor Charles Lincoln Edwards has been appointed naturalist of the Park Department of the City of Los Angeles, with the commission to plan a Zoological Park and Aquarium. In Griffith Park, with an area of 3,000 acres of mountain lands, the animals will have the freedom and atmosphere of the wild. The aquarium building, in the mission style, will be located on the ocean front cliffs of San Pedro in a marine park with tide-pools for sea-lions, sea-elephants and penguins.

Sir Patrick Manson, F.R.S., will retire from the post of medical adviser to the Colonial Office in London on August 15. He has been appointed a Knight Grand Cross of the Order of St. Michael and St. George, in recognition of his eminent services in connection with the investigation of the cause and cure of tropical disease. Sir J. Rose Bradford, F.R.S., has been appointed senior medical adviser, and Mr. C. W. Daniels, junior medical adviser, to the Colonial Office in London. Mr. W. T. Prout, late principal medical officer, Sierra Leone, has been appointed medical adviser to the Colonial Office in Liverpool.

We learn from the *Journal* of the American Medical Association that on the completion of his fortieth year as member of the faculty of the University of Berne, Professor T.

Kocher was given an ovation recently, by his friends and pupils. The Swiss government, the universities and institutes sent representatives, as did many of the European surgical societies. The *Deutsche Zeitschrift für Chirurgie* issued a special volume of 818 pages as a *Festschrift* in his honor. He celebrated the occasion by presenting the university with $40,000 to endow scientific research. It will be remembered that Kocher was awarded the Nobel prize in medicine in 1909 for his works on the thyroid. He was born August 25, 1841, and is thus in his seventy-first year.

Dr. Hermann Cohen, professor of philosophy at Marburg, has celebrated his seventieth birthday. On this occasion, Herr Siegfried Brunn, of Berlin, has given 100,000 Marks to the Jewish Institute of the university, for the establishment of a Hermann Cohen professorship.

Professor Malins, who has held the chair of midwifery in the University of Birmingham and Mason College, has resigned, and has made the university a gift of £1,000.

A gold medal has been awarded by the Royal Horticultural Society to Professor R. Newstead, F.R.S., of the University of Liverpool, for his exhibit of insects injurious to cultivated plants on the occasion of the Royal International Horticultural Exhibition held in London in May last.

Professor Rubens, director of the Berlin Physical Laboratory, has been elected president of the German Physical Society.

Dr. J. Reynolds Green has been appointed Hartley lecturer in vegetable physiology in the University of Liverpool.

Dr. Wilhelm Ostwald, formerly professor of chemistry in the University of Leipzig, expects to visit the United States this autumn.

Dr. S. W. Williston, professor of paleontology in the University of Chicago, will spend the autumn quarter of 1912 in an expedition to British South Africa. Professor Williston will be accompanied by Preparator Paul Miller, his assistant, who will spend the whole academic year in completing the work of the expedition.

Dean E. B. Greene and Professor G. A. Goodenough, of the University of Illinois, will attend the International Congress for the Interchange of Students in London on July 28.

Professor and Mrs. S. A. Forbes will attend the second International Congress of Entomologists to be held at Oxford, England, August 5 to 10. Dr. Forbes will go as a delegate from the Entomological Society of America, of which he is president; he will read a paper on the black fly pellagra problem in Illinois.

Mr. F. W. Rane, state forester of Massachusetts, has been delegated by Governor Foss to represent the state at the second International Congress of Entomology, which is to be held at Oxford, England, August 5 to 10, 1912. At the termination of the congress, Mr. Rane will go on to the Black Forest of Germany to study forestry conditions and the gypsy moth question.

A movement has been started in Baltimore to erect a monument to the dentist, Dr. Chapin A. Harris, who, with Dr. Horace A. Hayden, founded the first dental college in the world, the Baltimore College of Dental Surgery.

The University of Chicago has received five thousand dollars from Mrs. Myra T. Ricketts, widow of the late Howard T. Ricketts, assistant professor of pathology in the university, to found a scholarship to be known as the "Howard T. Rickett's Prize." This prize is to be awarded annually for the best piece of research presented by any student in the department of pathology and bacteriology. Dr. Ricketts lost his life in 1910 in the city of Mexico, from typhus fever, which he contracted while engaged in the scientific investigation of the disease.

On the occasion of the celebration of the bicentenary of the Trinity College Medical School, a bronze medallion was unveiled in the anatomical laboratory to Daniel John Cunningham, who was for twenty years professor of anatomy.

The death is announced of Dr. Moritz Seidell, honorary professor of pharmacology at Jena.

M. Florio Osmond, eminent for his contributions to the metallurgy of steel, has died at the age of sixty-three years.

The U. S. Civil Service Commission announces examinations to fill a vacancy in the position of plant pathologist, $2,750 per annum, Bureau of Plant Industry, Department of Agriculture; of entomological assistant (male), at salaries ranging from $1,400 to $1,800 per annum, in the Bureau of Entomology, and of assistant in agricultural technology for work in cotton grading, Bureau of Plant Industry, at salaries ranging from $1,200 to $2,250.

Since the summer of 1909 the joint commission appointed by the United States and Canadian governments to locate and mark the boundary line separating British territory from Alaska has been actively engaged in this work, pushing the line northward from the Yukon to Porcupine River by the end of the 1910 season. Last summer the field operations were advanced farther along that part of the one hundred and forty-first meridian which extends from Porcupine River to the Arctic Oceau, and it is believed that the present year will witness the completion of this part of the survey. Realizing that its well-equipped field organization afforded unusual facilities in this remote and rather inaccessible region for gathering much information not directly connected with the particular work of locatiug and marking the boundary line, the joint commission extended an invitation, which was readily accepted, to the Geological Survey of Canada and the United States Geological Survey to send geologists to accompany the field parties during 1911 and 1912, and to examine the geology along the boundary from the Yukon to the Arctic. The most satisfactory arrangement for making such a geologic examination in the two summers appeared to be to assign one of the two sections of the line to each government, as otherwise there would have been much duplication of work and the observers would be required to traverse the whole length of both sections. Under the arrangement adopted the Canadian geologists undertook to examine the southern or Yukon-Porcupine section and the United States geologists the northern or Porcupine-Arctic section. The United States geologists last year commenced field examinations in June and carried their work northward approximately 100 miles, to the headwaters of Firth River, which flows into the Arctic Ocean. A preliminary outline of the geologic results obtained by this party has been published by the United States Geological Survey as Bulletin 520-K, by A. G. Maddren.

UNIVERSITY AND EDUCATIONAL NEWS

An anonymous donor has given 10,000 guineas for the erection of a physiological laboratory for the medical faculty of University College of South Wales and Monmouthshire.

A motion has been placed on the records of the Supreme Court of the state of New York changing the official name of "The Trustees of Columbia College of the City of New York" to "The Trustees of Columbia University in the City of New York."

At the summer session of Columbia University there are registered 3,615 students; at the University of Chicago the registration is 3,053.

Dr. Edward Davidson Congdon, A.B., A.M. (Syracuse), Ph.D. (Harvard), instructor in anatomy at the Cornell Medical School, has been appointed instructor in anatomy at Stanford University and not at Pittsburgh as has been announced.

Professor Thomas L. Patterson, head of the department of biology in the Highland Park College, has accepted an appointment as associate professor of biology and physiology in the University of Maryland School of Medicine, Baltimore.

Dr. Ernst Gaupp, of Freiburg, has been appointed professor of anatomy at Königsberg.

DISCUSSION AND CORRESPONDENCE

SEX-LIMITED INHERITANCE IN CATS

To the Editor of Science: In Science for May 17, Mr. C. C. Little, under the title "Preliminary Note on the Occurrence of a Sex-limited Character in Cats," describes first results from the mating black female by yellow male, and concludes that the black and yellow factors are sex-limited in the male cat. For some years I have been collecting evidence on this question, and have recently begun breeding experiments, the first litters from which are expected very shortly. From evidence which I have obtained from breeders, and which I propose to publish when my own experiments are sufficiently advanced to provide adequate comparison, I have no doubt that Mr. Little is correct in supposing that the male cat shows sex-limited transmission of a color-factor. That this is so has been clear to me for two years or more, and I welcome Mr. Little's further evidence in the same direction. My data, including records of from 30 to 80 kittens in each of the possible crosses between black, orange and tortoise, do not, however, entirely confirm the hypothesis which he suggests. I have evidence, from a breeder who is thoroughly reliable, that occasional black (or blue) *females* are produced from the cross black female × yellow male, and also from tortoise female × yellow male. That such black females are unusual is quite certain, and it is of the greatest importance to determine under what circumstances they occur. Their existence would seem to indicate that the sex-limitation is not absolute, but partial, as in the case of gametic coupling between members of distinct Mendelian pairs.

Mr. Little, if I understand him, assumes that both black and yellow factors are sex-limited in the male cat. I think a more probable assumption is that all gametes bear the factor for black, which appears to be hypostatic (recessive) to all other colors, and that the yellow female is homozygous, the yellow male and tortoise female both heterozygous for the yellow factor. Using the terminology $X =$ male, $XX =$ female, $Y =$ yellow, y its absence, $B =$ black; and supposing that Y is closely, if not invariably coupled with X in the male, we have

Yellow male $= XYyBB$, producing gametes XYB, yB;
Yellow female $= XXYYBB$, producing gametes XYB;
Tortoise female $= XYyBB$, producing gametes XYB, XyB.

Yellow is normally completely dominant (epistatic) over black in the male, only partially so when heterozygous in the female, giving tortoise. It is possible that the exceptional tortoise-shell males are the correlative of the exceptional black females from yellow sires. If the coupling between the sex-factor X and the yellow factor Y is occasionally broken, then Y, transmitted from a male parent apart from X might perhaps behave differently from Y coupled with X, and produce a tortoise instead of a yellow male. Until further data are available, however, this kind of speculation is of little value. My main object at present is to point out that the complete solution of the problem requires large uumbers of observations, so that we may know not only what exceptional conditions are possible, but also the frequency and mode of their occurrence. My own experiments are unavoidably on a small scale, and with regard to data derived from breeders, it is notoriously difficult to avoid all chance of mistake unless the cats are kept in cages, a precaution not always taken by the amateur. It is therefore very desirable that further experiments should be done on a large scale, under absolutely trustworthy conditions.

L. Doncaster

Cambridge, England,
May 28, 1912

"TERMS USED TO DENOTE THE ABUNDANCE OR RARITY OF BIRDS"[1]

The paper under this title in a recent issue of Science seems to be another attempt to replace spontaneous choice by labored precept,

[1] Kuser, J. D., Science, N. S., Vol. XXXV., No. 911, June 14, 1912, pp. 930–931, chiefly a reprint from "The Birds of Somerset Hills," Rahway, N. J., 1912, pp. 128–132.

to substitute mechanical uniformity for individual freedom of expression. There is little probability that we shall ever fix upon a code of mathematically exact terms denoting abundance or rarity nor is there any need of so doing. What the term, a common bird, means in one place it does not mean in another. To understand its approximate meaning we must get a conception of a writer's whole work, the character of the region, the amount of time spent in the field, and the extent of country covered. This being the case, there is little ground for objecting to the use of a set of terms indicating relative abundance, because they are not patterned after some very precise model.

Few will conclude, as Mr. Kuser does, that "usually common or usually rare are the same as common or rare." Why deny us the use of the perfectly good and expressive word "usually"? We are glad to have extra-dictionarial information concerning the exact meaning of "quite" and "tolerably," but hazard the prophecy that "quite common" and "tolerably common" will be in good standing long after our author has passed from earth away. Some of the other dicta in Mr. Kuser's paper will not impress every one as convincing, for instance: "Not uncommon is equal to common," "accidental is occasional or rare." These words have by no means customarily been used in the sense indicated, nor have "scarce" and "irregular" usually had the significance Mr. Kuser gives them, that is, respectively, reduced in numbers after having been common and sometimes common, sometimes rare. In spite of our adviser's assertion that "rare is very rare," the mere fact that the two forms often occur in the same bird list proves they have distinct meanings.

Gentlemen who seek to control the use of language usually have the opportunity to learn that they are sadly misguided. For an excellent exposition of this principle see Professor Thomas R. Lounsbury's article, entitled "Schoolmastering the Speech."[2] We have always had "schoolmasters," or in a Rabelaisian synonymy, pedagogues, pedants, monitors, dogmatists, grammaticasters, censors, hypercritics, doctrinaires, editors, recensionists, revisers, highbrows, purists, Sir Oracles, precisians, language-rectifiers, admonishers, reformers, talk-tinkers, stylists, theorists, word-catchers and speech-conservers, but usage has been little affected by their efforts. The language still pursues the sweet and even tenor of its way. Word-histories prove the authority and freedom of usage in molding the language. The objections of pedants are no obstacles to this progress; they are no more than clods in the path. The great principle to be borne in mind is that language is made for man and not man for language.

W. L. McAtee

[2] *Harper's*, December, 1905.

In Science, June 14, 1912, pp. 930–931, I see that Mr. Kuser has attempted to formulate a standard of general terms to denote specific density of populations. Though the use of such terms as "common" or "rare" is, owing to the great amount of personal equation involved in their application, unsatisfactory, there is, at present, no practical method of substituting any better or more accurate system in their place. Some writers have tried to give an approximation to the number of individuals occurring in a given unit of territory, but, owing to the difficulty of counting or estimating a moving or secretive population, the results are often little more than the expression of an opinion more or less biased by personal view-point, and nearly as much a matter of judgment as the old methods. Besides which, the results, as expressed in figures, are unfamiliar to most of us and difficult to translate into comparable conceptions.

That some system of standardization of the common colloquial terms is desirable is self-evident. How far it can be accomplished is open to discussion. The decision of just how many individuals make "common" or how few make "rare" varies so greatly with the personality and experience of the observer, the species in question and the locality studied, that absolute uniformity of use and comparability of record seems difficult if not impossible of attainment. However, if absolute standardization can not be arrived at, it does seem possible that a comparative one can; whereby each observer's records may vary slightly from those of others yet be strictly comparable with themselves and approximately with those of others. To arrive at such a conclusion, some uniformity in the use of terms should be understood, and for such use a list of terms as before mentioned is of value.

To fulfill its mission, such a standard set of definitions should conform to the present-day average use, and the question is therefore, not what the strict dictionary or grammatical meaning may be, but what has been and is their meaning in present-day practise. Viewed in this light, I think Mr. Kuser's list is subject to criticism, and some objection can be made to his proposed use and interpretation of terms.

Should these remarks of mine be found not to tally with the conceptions of others, it will be but a concrete example of the variation in interpretation of these commonly used phrases and but another proof of the advisability of some such system of standardization.

Very Common.—Mr. Kuser says this is the same as "abundant." Are there not various degrees of commonness and does not a species become more common before it arrives at abundant? "Very common" is in such general use and carries such a clear concept that I should hesitate to discard it. At any rate, in practise it has not the same meaning as "abundant."

Usually Common.—Mr. Kuser says this is equal to "common." I think this is a mistake. According to my, and what I think is the general conception, "usually common" signifies that the species varies in numbers in time and place, but is more often common than not. It infers a rule with many exceptions.

Quite Common.—The academic and practical use of words is here confused. Though in theory the effect of the prefixing of the "quite" to "common" is neutral or slightly intensive, in practise it is diminutive and weakens the statement to "almost" or "barely common." "Quite common" is established in our literature, is well understood, and I can see no good reason why it should not be retained, though I should prefer to use "rather common" in its stead.

Not Uncommon.—This certainly does not in practise equal the same thing as "common" nor does "not common" equal "uncommon." In either pair, one term is passive and the other active. One means a little less than "common" and the other a little more than "uncommon."

Accidental is not "occasional or rare." The word does not apply to numbers at all, but involves an explanation of a lack of numbers. A storm-blown petrel appears in the Mississippi Valley accidentally, Kirtland's warbler is noted there occasionally; both are rare there, but both are not accidental. This is a word to be used with great caution. Except in a few cases, we do not know whether an occurrence is occasional or accidental, and it is much better, unless we know certainly to use the former term, which merely expresses an observed fact, than the latter, which adds a theory to it.

Very Rare.—As a species can be "common" or "very common" so it can be "rare" or "very rare." The degrees apply to rarity as well as to commonness.

Scarce.—I can not see that "scarce" has any meaning of diminishment. In general use I think it merely refers to present conditions and comes between "common" and "rare." The word to be used in Mr. Kuser's sense is "decreasing," and to be used in its adverbial form in conjunction with other terms of number as "decreasingly common" or "decreasingly scarce."

Irregular.—This is another word that has no quantitative meaning, but deals with the constancy or inconstancy of the numerical status. It can be used adverbially with other terms as "irregularly common."

It is easy enough to criticize others' work and with the certainty that they will find it equally simple to criticize mine I here offer an alternate scale of terms and definitions that seems to me a little more satisfactory, as it agrees with general practise and overcomes some of the difficulties about as well as can be expected.

As a basis I have taken four terms in general use that have (in my opinion) become more or less established in use and concept:

Abundant.
Common.
Scarce.
Rare.

Of course none of these terms can be defined by absolute numbers or density of population per unit of area. An equal number of song sparrows and golden eagles in a given territory would make either the former decidedly "rare" or the latter phenomenally "abundant." Therefore, in defining the terms I have tried to measure them by their effect upon the observer and not by the numerical occurrence of individuals. This, of course, has the objection of accentuating personality somewhat, but it follows the usual conception of the terms, and, if followed consistently, will make all observations of one recorder comparable with each other while affording some degree of uniformity between those of different observers.

Common.—This is the fundamental or zero of the system and all other terms must from time to time be compared with it. It is applied when individuals are noted in such numbers as to be readily found without special search. The test of commonness is when the observation of an individual, more or less, arouses little or no interest. When the observer passes by with the mental thought, "another song sparrow," and then dismisses the matter from the mind, the species is "common."

Abundant is applied when the species intrudes itself upon the senses so repeatedly that one can not help noticing it. In other words, when it is practically always present. The test for abundance is when the observer notes the numbers with a certain amount of interested surprise, and the mental ejaculation is "What! another song sparrow?"

Scarce.—Considerably less than "common." The test of scarcity is when the sight or observation of an individual arouses more or less passing interest and self congratulation. The accompanying thought might be expressed as, "Good! another song sparrow."

Rare.—Decidedly less in number than "scarce." The test is when the appearance arouses decided enthusiasm and a thought arises such as, "Hurrah! here is a song sparrow."

With each of these terms I should advise using qualifying adverbs such as "very" and "rather"; thus we have "very rare," "rare" and "rather rare"; "very common," "common" and "rather common," etc.

Irregular, or its adverbial form "irregularly," denotes fluctuation of number at different times.

Local or Locally denotes variability in geographical distribution.

P. A. TAVERNER
VICTORIA MEMORIAL MUSEUM,
OTTAWA, ONT.

"FLORIDA WEATHER"

IN reading Mr. A. H. Palmer's remarks on "Winter Weather in Florida" in the issue of SCIENCE for May 31, one wonders what unfortunate circumstances accompanied his experiences with Florida weather or whether he ever spent a winter in the state. One must believe from his remarks that in his opinion he has really discovered something about the climate of Florida not hitherto known.

While we do not question the accuracy of the official records he quotes, they are so arranged as to give an impression that is far from accurate. For instance, one would be led to infer that while California escaped the frosts of the past severe winter practically unscathed, Florida suffered severely; whereas the facts of the case are exactly the reverse of this. This false impression arises largely from his comparing northern Florida with the coast region of central and southern California, a comparison that is manifestly unjust. He deliberately chooses the coldest part of Florida (the record of — 2 was at Tallahasse, although he does not say so in his article) for comparison with the warmest parts of California.

One would further gather the impression that while the citrus industry of California is beyond danger, that of Florida is liable to be wiped out completely. While it is true that the freeze of February, 1895, killed a large part of the orange trees to the ground, the few groves then existing in the southern part of the state, where citrus planting is now most active, largely escaped, and most of the groves further north have long been in bearing again. In other words the grower of citrus has learned what Mr. Palmer has not learned, *i. e.*, that there is a difference in climate between northern and southern Florida, and has accordingly shifted the center of the industry a hundred miles further south. He has further learned to copy the methods of the California grower in being prepared to heat his grove in case of need.

As to the frost at Miami, the author knows from personal observation that tomatoes were not injured and every gardener knows that a frost that will not kill tomatoes does not cut much of a figure. Furthermore the temperature given for San Francisco and Los Angeles (42) is perilously near the danger point for frost, a fact that Mr. Palmer fails to mention.

While every night may not be a "June" night, in the writer's opinion our coldest days, even in this part of the state, so far as personal comfort is concerned, compare very favorably with some "June" days he has experienced on the shores of Lakes Erie and Michigan.

One should not attempt to draw conclusions as broad as his on such limited data. Figures of minimum temperatures, although valuable, fall a long way short of telling the whole story as to the desirability of a state as a winter resort. The average temperature during daylight, for instance, is a point much more important.

I am impelled to write this protest because of the amount of harm such an unjust article can do to a community.

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SCIENTIFIC BOOKS

The Mechanics of the Aeroplane. A Study of the Principles of Flight. By Captain Duchene. Translated by Ledeboer and Hubbard. Longmans, Green & Co. 1912. 231 octavo pages, 91 diagrams, 4 tables in the text and 5 in the appendix.

This is an elementary technical work on the principles of the aeroplane. It is neither accurate enough nor comprehensive enough to be called a popular treatise. It presents in rough and ready practical form the latest results of theory and experience, and therefore should prove welcome to engineers who practise aviation professionally, rather than investigate profoundly or precisely.

It is divided into four parts aggregating six chapters. The first part treats of flight in still air; the second part treats of equilibrium of the aeroplane in still air; the third discusses the effect of the wind on the aeroplane; the fourth presents one chapter on the theory and design of the screw propeller. In all the text care is taken to preserve the theoretical nature of the work, and not to cumber it with descriptions of machines, details of construction, or historical references.

The work would be improved by eliminating certain misleading passages. Thus the author states that the wind force on a plane at small angles of incidence is almost normal to the surface, whereas it is well known that the force may be very oblique at small angles, being actually tangential to the surface at zero incidence. Again he states that many constructors design their propellers with a curved leading edge because the streaky marks on the propeller-blade made during rotation, by dust particles and oil, assume this shape. As the author presents without protest or repudiation this absurd reason of the practical designer, the reader naturally infers that the author either endorses the absurdity or suspends judgment. One skilled in aerodynamics can not entertain such a reason for curving the leading edge of a propeller blade.

On the whole the book is a good presentation of the most advanced information on the physical basis and the mechanical theory of aviation, and contains many useful and concisely solved problems that will appeal to amateurs and professionals devoted to the practical study of the aeroplane. A special commendation of the work is that it was awarded the Monthyon prize in 1911 by the French Academy of Sciences.

A. F. Zahm

Smoke—A Study of Town Air. By J. B. Cohen and A. G. Ruston. New York, Longmans, Green & Co. 1912.

Among the principal disadvantages attendant upon our modern civilization is the smoke produced wherever soft coal is burned. As in so many other cases, the possibility of doing away with the evil rests, to a great extent, upon the sufficient arousal of public opinion; in this instance, that there may be enacted the legislative measures necessary for the enforcing of the smokeless combustion of soft coal.

The means and methods of burning soft coal without smoke, having been the subject of numerous publications, are well known. But attention to other phases of the subject, which are so necessary for the enlisting of public sympathy, are remarkably lacking.

In point of fact, this little book by Cohen and Ruston is the first attempt to gather what little information we already possess along these lines into such form as to be accessible to and easily comprehended by the general public.

This book, therefore, takes one into a field, new to the average reader, and gives him a point of view different from that to which he is accustomed. It is, thus, eminently worth while.

The first chapter has to do with the chemical composition of soot and shows why it is obnoxious and injurious. Reliable figures are given for the amount of soot formed from a definite amount of coal burned, for the solid impurities in the air—and for the daily soot fall in various towns in England.

The effect of smoke on vegetation is treated with considerable detail and is shown in many cases to be decidedly injurious.

The effect of sulphuric acid in the air upon metal work and vegetation, here gone into at length, while interesting to know, is somewhat out of place, as the smokeless combustion of soft coal will not do away with the acid emitted from our chimneys.

The study of the diminution in the transparency of the air and the increase in fogs due to smoke forms an instructive discussion.

The chapter on the influence of coal-smoke upon health, by Dr. Ascher, is a valuable addition to the book, showing that, "there can be little doubt that coal dust smoke and soot increase the death rate from acute lung diseases."

Altogether it is a clear, concise and, above all, trustworthy collection of data concerning smoke and soot and the damage done by them.

R. C. Benner

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General Index to a Hand-list of the Genera and Species of Birds: [Nomenclator avium tum fossilium tum viventium.] Volumes I.–V. Edited by W. R. Ogilvie-Grant. London: Printed by order of the Trustees. Sold by Longmans & Co., 39 Paternoster Row, E. C.; B. Quaritch, 11 Grafton Street, New Bond Street, W.; Dulau & Co., Ltd., 37 Soho Square, W.; and at the British Museum (Natural History), Cromwell Road, S. W. 1912. All rights reserved. 8vo. Pp. vi + 199.

Dr. Richard Bowdler Sharpe's "Hand-list of the Genera and Species of Birds" (5 vols., 8vo) was completed in 1909.[1] Although each of the five volumes (except the first, indexed with volume II.) was supplied with an index, a general index has been prepared, under the editorship of Mr. W. R. Ogilvie-Grant, Dr. Sharpe's successor in charge of the ornithological collections in the British Museum, "to supply a much-felt want." The task of amalgamating the indexes to the five volumes was done mainly by Mr. Grant's chief assistant, Mr. Thomas Wells. We are told in the

[1] Reviewed in Science, N. S., Vol. XXXI., No. 790, pp. 265–267, February 18, 1910.

editor's preface that a good many errors and omissions were found in the original indexes, and to correct these and to provide a general index it was decided to issue the present work as a "Supplement" to the "Hand-list." It contains about 22,000 entries, and its usefulness will be greatly appreciated by those using the "Hand-list," or, in other words, by all systematic ornithologists.

The preface to the volume is by Dr. Sidney F. Harmer, keeper of zoology in the British Museum, and contains a tribute to Dr. Sharpe's long period of distinguished service as curator of birds at the museum.

J. A. A.

Heredity and Society. By W. C. A. Whetham and C. D. Whetham. Longmans, Green and Company. 1912. Pp. 190.

Of late years the attention of all who have at heart the welfare of mankind in this country has been attracted by two main facts: first, the reduction of the birth rate in the more progressive and effective part of our population to half or less than half of what it was formerly, and the great increase in the number of inmates of institutions. Indeed, the proportion of our population that receives state care has nearly doubled in the ten years from 1890 to 1900, and shows an increase much larger than that of the population from 1900 to 1910. This increasing care of the defectives is a heavy burden. One seventh of the income of the state of New York goes to maintain and enlarge the state institutions for insane and other defectives—in some recent years the proportion has risen to one fifth, and it tends to increase. In view of these facts the inquiry has naturally been raised: What is the cause of this increase and what is the way to stop it? And the answer has come back from the students of heredity, carrying with it overwhelming conviction: the defectives are *bred,* and the way to stop the rising cost of their care is to stop breeding them. We are brought to our present pass by the care we have taken to protect, rear and let breed, the worse elements, while discouraging the reproduction of the better.

In England the same general phenomena that strike us here are evident, and a eugenics movement has gained great headway there. Among the leaders in this "movement" have been Mr. and Mrs. Whetham whose "Family and the Nation" has had a great influence. The present work is destined to play an equally important part. It consists of a series of thoughtful and interesting essays touching the biological aspect of the family. One can not summarize the essays, and most of them are beyond criticism. They must be read.

In the chapter on variation and heredity some of the well-known cases of family genius are cited and some new ones, based on studies of a Biographical Dictionary, are given. The authors point out that the explanation of why some men of distinction have sons of distinction and some do not depends on the kind of marriages the men make. It might have added that the reason why geniuses are rare is because, depending on recessive conditions, they will reappear in the next generation only when two strains with the tendency to like genius are brought together.

In the essay on natural selection the disastrous consequences to the race of extensive sanitaria for consumptives and of eliminating the death penalty are suggested; but there is far more to be said on this subject than the authors say in this chapter. In the essay on the biological influence of religion, the authors point out that the hardship that the Jews have undergone in the past has given them racial strength and that in face of a more humane treatment they may be killed off by kindness. In how far may the keenness and shrewdness of the Jew be due to the elimination of those who were not shrewd enough to escape their persecutors?

The two essays on the position of women contain much food for thought. The incursion of women into the industrial field as wage earners coincides in time with the fall in birth rate. And in so far as the best women are lured into professional and political life, or fail to become mothers, the best bearing branches of the racial tree are being cut off—

flowers of the most precious strains in the garden of life are being plucked before they produce seed.

The essay on heredity and politics is one of the best in the book. A successful nation is a powerful nation, and the authors conclude: "A 'theory of power' which takes account of modern biological knowledge in a strenuous effort to improve the physical, mental and moral state of the race, by both environment and heredity, and by their interaction one on the other, seems to us a good basis for political endeavor." Increasing the men of genius will make possible improved environment, but if racial efficiency fall civilization must decline. And the civilized nations spend their substance in caring for the unfit for whom the fit are taxed to such an extent that they can not carry the added expense of children. So it has come about that only the weakling can afford to have children in unlimited numbers, since the state will care for *their* children. The handicap on the fit is too heavy; it is they, and not the unfit, who are, in effect, being sterilized. A governing class becomes such and maintains itself by virtue of its inherent strong traits. Even in democratic America the opportunities afforded by business have lured the strongest men into it, and so "big business" has come to constitute the governing class. And as between nations, that which breeds the most of the best blood, while taking advantage of the advances of science and sanitation, will eventually surpass the others and inherit the earth.

C. B. Davenport

THE INHERITANCE OF SKIN COLOR

The mulatto is frequently instanced as a "blend"; and an exception to the Mendelian scheme of inheritance in that he is supposed to breed true. This position, I believe, represents an off-hand judgment based on insufficient evidence or faulty observation. I have seen a number of unquestionable cases of "reversion" to grandparental skin color among the fraternities of mulatto crosses. In numerous instances one of the third generation is either darker or lighter than either parent, *i. e.*, he has the skin color of his negro grandmother or his white grandfather, this being the invariable nature of the cross.

A man is a combination of thousands of characters; skin color is only one of these. When one considers the offspring of mulattos one must remember that such may have a negro skin associated with a European nose, or negro lips with white skin. One meets with plenty of mulattos that from the standpoint of skin color alone are white, brunette or blond; but one is not deceived as to their extraction since negroid features appear in combination. The probable explanation of the general opinion that mulattos breed true, contrary to the Mendelian principle of segregation, is due to this fact of failure to dissociate skin color from other facial characteristics. The Davenports[1] cite five cases of undoubted segregation of skin color in the third generation. Such families are fairly common in the south. I have shown, moreover, that histologically there is no difference between the skins of blonds, brunettes, mulattos and negroes, except in the abundance of identical pigment granules.[2] Histologically, many mulatto skins can not be told from brunette skins.

The heredity of skin color in crosses between negroes and whites unquestionably follows Mendelian laws. The mulatto shows the dominance (frequently imperfect) of the deeper pigmented condition. In the next-succeeding generation there is again a segregation of negro and white skin colors.[3] The fact, however, that the first generation of

[1] *Am. Nat.*, Vol. 44, 1910.

[2] *Am. Nat.*, Vol. 45, 1911.

[3] The same is true with respect to an extensive Indian-negro cross which occurred in Amherst and Nelson counties, Va., resulting in the loss of an entire Indian tribe. I am told that in many families one or several of the children are distinctly more Indian or more negro than the prevalent type of the cross. Here again the negro skin color seems dominant to the Indian; on the contrary, the Indian type of hair apparently dominates over the kinky negro hair.

mulattos is frequently not as dark as the negro parent, and among the second (F_2) generation one or several may be darker than the darkest mulatto parent and one or several lighter, without being quite as dark or as light as the negro or white grandparent respectively, suggests strongly that a complex of factors is involved.

The fact of the apparent histologic identity between brunette and mulatto skins; and the further fact that under protracted exposure to extremes of heat and sun the number of pigment granules is increased in white skin, indicates that pigmentation (dark skin) as evidenced in the negro is an instance of the inheritance of an acquired character. The least that makes a negro a negro is his dark skin. Life-guards in September are frequently almost as black. A negro is specifically such for mental perhaps more than for physical characteristics. Moreover, the negro originally hails from tropical regions; he has been for unknown periods of time exposed to the hot tropical sun. In foreign lands he thrives best in hot climates. Pigmentation in him has probably arisen as a response to a protective demand against the rays of the sun, just as whites now acquire a "tan" under similar less extreme and less prolonged conditions. This line of reasoning would appear cogent enough, but unfortunately it can not be experimentally tested. In the absence of such test it must remain simply a speculation.

Moreover, if Kingsley's quotation in "At Last" of a description of the inhabitants of Saba by the Bishop of Antiqua is to be trusted, the results of one of nature's experiments along these lines militates against the speculation. The Bishop spoke of them, Kingsley says, as "virtuous, shrewd, simple, healthy folk, retaining, in spite of the tropic sun, the same clear white and red complexion which their ancestors brought from Holland two hundred years ago—a proof, among many, that the white man need not degenerate in these places."[4]

The two most obvious explanations of negro deep pigmentation are the one outlined above, *i. e.*, acquired in response to a peculiar environment and transmitted; and as inherited from anthropoid ancestors. The evidence yielded by the inhabitants of Saba of the West Indies renders inadmissible the first. What facts support the latter interpretation?

In the first place the negro is a primitive type of man, as indicated by numerous anatomic marks (*e. g.*, relative length of arms and legs, male external genitalia—prepuce covers glans—shape of nose, use of hallux, etc.) which are more or less infantile European characters. He apparently stands much closer in the evolutionary scale to the anthropoid apes, with pigmented faces. The negro may have inherited his dark skin from his pigmented pre-man ancestors. He may be habitually an inhabitant of the tropics because he alone could survive in that climate, or because he was best suited and thus more comfortable there. The dark-skinned races, like the Italians and Spanish, and finally the brunettes of the Anglo-Saxon race, may owe their pigmentation to negroid ancestry. The connecting link may well have been the negro slaves of Roman times, and the conquering Teutons.

Moreover, anthropoid ancestry may account more directly, *i. e.*, without negroid intervention, for the pigment of "whites"; or, as in numerous other instances, so in the case of pigmentation, we may simply be dealing with an instance of parallelism. Similar results of varying degrees may have been attained under the influence of similar conditions, at various times and various places. It seems impossible at present to arrive at a definite conclusion. Complete knowledge on this point may perhaps never be forthcoming. The above discussion indicates the possible origin of a multiplicity of factors in skin-color determination. However, regarding the histologic similarity between light and deep pigmented skins and a measure of segregation among the children of black-white crosses there remains no question.

H. E. Jordan

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[4] P. 23 (ed. 1910, Macmillan & Co.).

SPECIAL ARTICLES

A REVERSAL OF THE ROWLAND EFFECT

THE result of Rowland's Berlin experiments showed that a wire having a supercharge of negative corpuscles, moved longitudinally in a plus direction, and a wire having less than a normal charge, moved in the opposite direction, would produce the same external field.

In a paper just being issued by the Academy of Science, of St. Louis, the writer shows that when this external field is imposed upon a wire, the corpuscular column within the wire, and the wire itself, are moved in opposite directions.

A copper wire having a diameter of about 0.2 mm. and a length of 55 cm. is placed within a horizontal glass tube of three or four mm. diameter and 50 cm. in length. About 1.5 cm. of the wire at each end is bent at right angles and hangs vertically. Spark knobs on long rods connected with the terminals of an eight plate influence machine, are placed directly over the ends of the tube. A condenser of sheet glass having an area of tin-foil on each side of 1,000 or more sq. cm. is connected with the discharge rods. The spark length was about 4 cm. at each terminal. Sparks passed into the side of the wire at the ends of the tube, at intervals of one to three seconds, depending upon the length of the spark. The machine was driven by a motor. The end of the wire was observed by means of a telescope magnifying about 27 diameters.

No motion of the wire due to a single spark can be observed, but after four or five sparks have passed, one can easily see that it has moved.

The ends of the wire are slightly lifted as the potential rises, and drop when the spark passes. The entire wire is somewhat shaken by the spark, and the effect is to somewhat diminish friction. The interaction between the ends of the wire and the surrounding air is very slight, but it is directed at right angles to the direction in which the wire creeps.

In one case the effect of 3,500 sparks caused the wire to creep over a distance of 1.2 cm.

The paper contains other evidence that such a solid conductor has the properties of the positive column. In one case a ¼ ampere fuse wire in a tube filled with coal oil was fused by a single spark, and became solid again at the instant when it had buckled into a regular series of longitudinal waves. In one case the compression halves of the waves separated into minute spheres, there being about a thousand of them distributed quite uniformly over a half meter of the tube.

No creeping of the wire could be observed, when the ends were dipped into mercury cups and a separately excited dynamo having a terminal potential of 175 volts was momentarily connected with it. Such effects have been observed when high potential discharges wholly outside of the wire have passed between the terminals of the influence machine. These effects have not yet received careful attention. The action of the coherer is of this character.

FRANCIS E. NIPHER

THE PREPARATION OF UNBROKEN POLLEN MOTHER-CELLS AND OTHER CELLS FOR STUDIES IN MITOSIS[1]

SOME recent investigations in the study of pollen mother-cells without the use of the microtome have made it evident that there are certain advantages in preparing and studying unbroken cells for investigation in mitosis. Those in the Bureau of Plant Industry who have examined this method have suggested that a short paper be presented to this society, in order that other workers may try out this method and cooperate in improving its technic. The method seems to be capable of quite wide application in karyokinetic study.

The stamens of a large percentage of our flowers yield the unbroken pollen mother-cells with very little difficulty. Such plants as the grasses, including our grains, supply an abundance of material by simply placing the anthers in a drop of water, cutting the tips with a sharp scalpel and gently tapping them with

[1] Read before Section of Botany, American Association for the Advancement of Science, 1911 meeting, Baltimore, Md.

the point of a dissecting needle. The pollen mother-cells float out uninjured. Most other genera are easily treated in the same way. A few genera present difficulties; *e. g.*, the Malvaceæ, where the anthers are so charged with mucilage that the mother-cells can not be handled successfully without considerable trouble.

Before passing to the technic, which is exceedingly simple, I wish to say that the method can readily be adapted to study of the cells of more compact tissues by the simple process of teasing out with needles a few cells and separating them from the rest of the tissue. Although the microtome method is of extreme value to every worker, it has the tendency of tyrannizing over all other methods, some of which are unquestionably better for special purposes.

The killing of the pollen mother-cells can be done either while they are still in the anthers or after their separation. I have found weak Flemming's solution excellent, but Bouin's solution, on the whole, the better for this purpose. It has long been a favorite of the zoologists, but rather neglected by botanists. The formula is:

Picric acid, sat. aq. sol.	75
Acetic acid, glacial	5
Formalin, commercial	20

Fix 4 to 8 hours; wash with 50 per cent. alcohol until no color remains, in which the material may then be kept indefinitely.

After killing and washing, the pollen mother-cells are stained in toto by any satisfactory method. I find that both Heidenhain's iron-hematoxylin and Hermann's modification of Flemming's triple stain are especially good. The latter works vastly better than the regular Flemming stain. The formula is:

Safranin, water soluble	1
Alcohol	10
Anilin water	90

Stain 4 to 8 hours; wash in 50 per cent. alcohol and, if necessary, in acidulated 50 per cent. alcohol. Pass into

Gentian violet	1
Alcohol	10
Anilin water	90

Stain 2 to 6 minutes; wash in water. Pass into Orange G., aq. sol.

I find the concentrated aqueous solution too intense, therefore dilute it with 9 volumes of water. Stain 1 to 3 minutes. Wash quickly in 50 per cent. alcohol and finish with absolute alcohol.

The material is cleared in cedar oil or, where dampness is a drawback to this method, in oil of cloves. There need be no shrinkage whatever in the finished preparation and there can be practically no disturbance in the arrangement of the cell contents.

Pollen mother-cells thus prepared present to the investigator the original packages with unbroken walls, from which no histological particle has escaped. The karyokinetic figures are complete. The chromosomes are all in situ, not sliced up into incomplete ribbons that need to be matched in successive sections, but each one complete and undisturbed. The whole machinery of mitosis, as well as all the adjacent cell contents, make an unbroken unit. The picture under the eye is that of a lot of spheres, transparent, translucent, revealing the contents, with as little chance of artifacts as is possible by human methods.

By mounting such cells in a somewhat limpid medium, such as heavy glycerine or thin Canada balsam and placing a triangular blotting-paper at one side of the cover-glass, the cells may be rolled over under the observer's eye, presenting to view all sides of the karyokinetic spindle and enabling one to count the chromosomes, to notice their position, and to study the entire mechanism with an ease and an absolute certainty that no series of sections can possibly equal.

Three points in this method deserve emphasis:

1. *The comparative ease with which pollen mother-cells can be secured in an unbroken and perfect state,* and prepared for observation as to their internal structure.

2. *The positiveness of interpretation* that can be secured by this method in contrast to

the vexing uncertainties of microtome methods, with which we are all too familiar.

3. *The great saving of time* in arriving at results, because of the elimination of the processes involved in imbedding and sectioning the material.

It may here be stated that a preliminary examination of the pollen mother-cells and of cells secured by needle dissection is greatly aided by the use of a concentrated solution of chloralhydrate, 8 parts of chloralhydrate to 5 of distilled water. This is far better for general use than phenol, eau-de-Javelle and similar clarifying reagents. It will enable the worker to tell at once if the cells under observation are in that particular stage of karyokinesis that it is desired to secure, as the spindles and chromosomes are rendered sufficiently visible to determine the mitotic stage. The regular treatment above described can then be carried out.

The writer would be thankful to hear from any members of the society who, upon investigating the foregoing suggestions, have adverse criticisms to offer or suggestions of improvement to make.[1]

Albert Mann

Office of Agricultural Technology,
U. S. Department of Agriculture,
Washington, D. C.,
December 15, 1911

[1] Before presenting the above paper I tried to find if a description of this method had been previously published, but could find no trace of it. Since the meeting of the association I find that Professor E. H. Campbell describes a similar process in *Bull. Torrey Bot. Club*, Vol. 17, p. 117. As, however, Professor Campbell's article does not agree in technic with my own, and as it is also evident that this desirable process is not widely used, I think it desirable to publish the paper together with this reference.

RESULTS OF PURE CULTURE STUDIES ON PHYLLOSTICTA PIRINA SACC.[1]

In the summer of 1911 a study of *Phyllosticta* in connection with the frog-eye leaf spot of apples was begun at the Virginia Experiment Station under the direction of Dr. H. S. Reed. Four distinctly different types of *Ph. pirina* were isolated from leaves collected at Blacksburg, Va., by the poured plate method. The different types are possibly elementary species in the De Vriesian sense of the term or pure lines according to Johannsen's use of the term, but will be called strains in this preliminary report.

Microscopically there is much similarity in these strains, except in Nos. 1 and 4 where chlamydospores are produced. The conidia of all four are identical in all characters and the mycelium of only one can be told from the others. The conidia are one-celled, elliptical, hyaline, sometimes with two oil drops. When grown on the same medium no difference in size is noted. On apple leaf agar these spores measure on the average 2.2 $\times$ 4.8 microns. The manner of pycnidia and conidia production is the same with all strains.

The macroscopic characters are quite different and any strain may be easily recognized in pure culture. For the sake of convenience these strains have been numbered 1, 2, 3 and 4. So far they have been grown on only three media, viz., apple leaf agar, apple fruit agar and synthetic agar made according to the following formula:

NH_4NO_3	10.0 g.
K_2HPO_4	5.0 g.
$MgSO_3$	2.5 g.
Cane sugar	50.0 g.
Agar agar	20.0 g.
H_2O	1,000 c.c.

Descriptions of test-tube cultures of these four strains of *Ph. pirina* on the three media used and some microscopic features follow:

STRAIN NO. 1

Apple Leaf Agar.—Growth diffuse; mycelium brownish in mass; aerial hyphæ short, snow white, sparse except at top and sides of slant or sometimes in patches on surface of culture; pycnidia small, very dark brown to

[1] Paper No. 17 from Laboratory of Plant Pathology, Virginia Agricultural Experiment Station.

black, erumpent, produced at random mostly near line of streak.

Apple Fruit Agar.—Growth very abundant; aerial mycelium growing in very dense, greenish gray patches in center and whitish around edges of culture; pycnidia black, small, abundant, produced mostly along line of streak.

Synthetic Agar.—Growth very thick and somewhat stromatic along middle; greenish-black and white on surface, usually with the white in the central part of the culture with a greenish-black band around it. Surface becoming black all over with age.

Microscopic Features.—Conidia, mycelium, pycnidia typical. Large numbers of one-celled, black chlamydospores produced on mycelium by simple swelling and thickening of certain cells. These chlamydospores have germinated after six months' drying in the laboratory and produced typical colonies of the fungus again. These spores are thick-walled and resistant and no doubt aid in tiding the fungus over unfavorable conditions.

STRAIN NO. 2

Apple Leaf Agar.—Growth diffuse; mycelium very light brown in mass; aerial mycelium practically none; pycnidia extremely abundant, produced usually over the whole surface of the culture with a distinct concentric ring formation even in tube cultures. Sometimes the pycnidia are produced so thick and close along the line of streak that they form a well-marked black line. Conidia ooze out in distinctly pink masses. This character alone serves to distinguish No. 2 from the others. This strain is a very prolific spore producer.

Apple Fruit Agar.—Diffuse; numerous pycnidia mostly in a wide strip along line of streak with a few scattered ones at base of slant. Aerial hyphæ short, gray all over the surface of culture. Spore masses pink.

Synthetic Agar.—Diffuse; pink; with long, fluffy, pinkish-white aerial mycelium covering surface of culture and growing up on sides of tube. In some of the tubes this aerial mycelium has a bright-green cast at apex and base of culture. Pink pycnidia very abundant all over the surface and some even produced up on the sides of the tube above the agar. A decided tendency to concentric rings is noted.

Microscopic Features.—Conidia, mycelium, pycnidia typical. No chlamydospores.

STRAIN NO. 3

Apple Leaf Agar.—Diffuse; mycelium dark brown in mass; aerial hyphæ gray, matted together, rather abundant over most of the surface. Pycnidia abundant, very small, black, erumpent, quite evenly distributed over the surface of the culture with some tendency to concentricity of arrangement. Agar turning quite black throughout.

Apple Fruit Agar.—Very diffuse but shallow. Surface covered all over with a dense growth of long, greenish-gray aerial mycelium. By holding to light the numerous black pycnidia can be seen through the aerial mycelium arranged in concentric rings.

Synthetic Agar.—Growth abundant; surface covered with a pink mycelial mass; aerial hyphæ very short, pink. Pycnidia inconspicuous.

Microscopic Features.—Same as No. 2.

STRAIN NO. 4

Apple Leaf Agar.—Diffuse; mycelium in mass very dark; aerial mycelium abundant, gray, quite dense. Pycnidia minute, black, abundant, evenly distributed, inconspicuous. Distinct concentric rings have been noticed, due to difference in color of different zones of the mycelium.

Apple Fruit Agar.—A very dense growth of short, greenish-gray aerial mycelium forming a mat over surface. Pycnidia very abundant, minute, inconspicuous, black, evenly distributed.

Synthetic Agar.—Dense stroma-like mass, greenish-yellow on surface. In some tubes the green is very pronounced around the edges, while yellow predominates in the center. Pycnidia inconspicuous.

Microscopic Features.—Mycelium rather larger than in other strains and noticeably darker, with a few one- to several-celled, dark brown to black chlamydospores.

The above descriptions will serve to distinguish these strains readily. Details of morphology and results of more culture work will be reported later. Since these four strains were so easily obtained last summer it is very likely that more strains may be isolated by extending the work and the field. This difference in strains of *Ph. pirina* may account for the fact that investigators disagree as to the parasitism of *Phyllosticta*. They may have worked with different strains, some of which may be parasitic, while others are purely saprophytic or, at most, facultative parasites. Inoculation experiments to throw further light on this phase of the subject are now under way and results will be reported in a later publication.

C. H. Crabill

Blacksburg, Va.,
May 1, 1912

THE NORTH CAROLINA ACADEMY OF SCIENCE

The eleventh annual meeting of the North Carolina Academy of Science was held at the University of North Carolina, Chapel Hill, on Friday and Saturday, April 26 and 27, 1912.

The meeting of the executive committee, held early in the afternoon of the first day, was followed by a general meeting for the reading of papers. At the night session the academy was welcomed to Chapel Hill by President Venable, of the university, and then President H. V. Wilson, of the academy, delivered his presidential address, "Zoology in America before the Present Period." Next Professor A. H. Patterson gave a demonstration of luminous electric waves. Then by invitation Dr. Thos. W. Pritchard read a paper, "Wood Distillation," descriptive of the fitting up and working of a plant at Wilmington, N. C., for the utilization of waste pine wood. At the same hour Dr. W. S. Rankin, secretary of the state board of health, delivered a lecture on hygiene and sanitation before the student body of the university in Gerrard Hall.

Adjournment was then had to the hospitable home of Dr. Isaac H. Manning, where a smoker was given the members of the academy by the local members.

On Saturday morning at 9 A.M. the academy convened in annual business meeting. Reports were made by the secretary-treasurer and by the several stated committees. Five new members were elected. These with the 85 members on the roll on January 1 give a total membership of 90. The report of the secretary-treasurer showed that in membership, in interest shown in its work and in its finances, the academy has never been in better condition.

The following officers were elected for the ensuing year:

President—C. S. Brimley, Raleigh.

Vice-president—John F. Lanneau, Wake Forest College, Wake Forest.

Secretary-treasurer—E. W. Gudger, State Normal College, Greensboro.

Additional Members of Executive Committee—Julian Blanchard, Trinity College, Durham; S. C. Clapp, State Department of Agriculture, Raleigh; John A. Ferrell, State Board of Health, Raleigh.

At 9:30 the academy and the North Carolina Section of the American Chemical Society held a joint meeting, at which Dr. J. E. Mills, of Columbia, S. C., presented a report on "Molecular Attraction and Gravitation." Following this the reading of papers on the program of the academy was resumed.

The total attendance was 31 out of a membership of 90. In addition to the special papers already noted, there were 29 numbers on the program. Of these four were read by title, the other 25 were given in order when called for. Two things characterized the meeting. First the number of papers dealing with hygiene, sanitation and public health; and second the discussion which followed the presentation of nearly every paper.

In addition to the presidential address and other papers previously noted, the following were presented:

Notes on the Distribution of the More Common Bivalves of Beaufort, N. C.: Henry D. Aller, Director U. S. Fisheries Laboratory, Beaufort, N. C.

Of the approximately 90 species of bivalves found in the vicinity of the U. S. Fisheries Laboratory at Beaufort, N. C., 39 are considered in this paper. Since those found sparingly and those dredged in deeper water offshore, or those represented by valves cast up on the beach, are not available for scientific purposes, only the more common forms are dealt with. It is the purpose of this paper to indicate which species are available in a living condition, specific localities where they may be found and so far as possible to give some idea of their abundance.

While a paper of this kind is of necessity incomplete, it is hoped that it may be of service to prospective investigators by pointing out what material they would have at their service under ordinary conditions at Beaufort.

The full paper is published in the current number of the Bulletin of the North Carolina State Board of Health.

The Value of Vital Statistics and their Relation to Public Health: Warren H. Booker, State Board of Health, Raleigh.

Vital statistics are valuable to the nation, since they enable us to study at close range the general movements of mankind, and to measure quickly the effect of any line of action on these movements. We should know as much concerning life and health conditions throughout the state and country as we now know about crop and weather conditions.

Vital statistics are valuable to the individual in many legal questions involving facts concerning births and deaths.

Students of medicine and sociology find the study of vital statistics very profitable.

The greatest value of vital statistics is found in connection with their relations to public health work. They indicate the kind of work that is most needed; also the efficiency of that work. Cities, towns and localities having abnormally high preventable death rates can readily be found and shown where and how to take the necessary steps to reduce these death rates. Reduced death rates will eventually form the measure of public health work.

The full paper will appear in the current number of the *Journal of the Elisha Mitchell Scientific Society.*

Further Notes on the Yellow-fever Mosquito at Raleigh, N. C.: C. S. Brimley, Raleigh.

Describes their great abundance during the summer of 1911, and gives possible reasons for the same.

This paper is published in the current number of the *Journal of the Elisha Mitchell Scientific Society.*

Race Preservation: Rev. George W. Lay, Rector of St. Mary's School, Raleigh, N. C.

All nature is one, and there is unity in the one plan that includes natural science and religion. Natural science has turned over part of its subjects to other departments, *e. g.*, light and sound belong to psychology as well as to physics. In eugenics natural science must go beyond the purely moral forces of evolution, and include the mental and moral forces of mankind. Environment must likewise include the mind and will of man as well as things purely natural.

The two great forces which govern natural evolution are the appetites, which secure the preservation of the individual in one case, and of the race in the other. Nature works preeminently for the race and is prodigal with individual life. When the mind of man enters into the methods that are applied to the breeding of the lower animals, a new element is added. He has used both the above laws in breeding and has sacrificed the individual to the race, as nature does. The results have been beneficial, and have been attained much more quickly than could be the case under nature alone, and have been in accordance with a preconceived plan. The resulting breeds are better suited to their environment only in case the mind of man is added to the purely natural forces as a part of that environment.

In eugenics, which is the effort to improve the breeding of human beings, the moral and religious principles of mankind are added as a new force to those previously mentioned. Here man has largely disregarded the natural forces that sacrifice the individual to the race, and has therefore worked only to preserve the individual. The result has been a partial failure, since the natural forces that preserve the race, largely at the expense of the individual, have been ignored.

The scientist and moral teacher must learn from each other and help each other. The scientist must recognize mental and spiritual things as true forces in the evolution of the human race, and the moralist must recognize that both the purely natural forces, working through the two kinds of appetites whose misuse leads to the deadliest sins, and on whose nature the two great sacraments are founded, are no less a part of the divine plan than those spiritual forces which constitute the special function of religion. We can not interfere with the great plan of the universe, or use any of its forces, unless we consider it as a whole, whose parts are in complete and necessary harmony.

To be published in full in the Bulletin of the North Carolina State Board of Health.

Notes on the Larvæ of the Marbled Salamander: E. W. Gudger, State Normal College, Greensboro.

Larvæ one and a half to two and a half inches long, with external gills, have been taken in brooks in the college park for several years past. This spring some thirty or forty were taken in a muddy pool in the same park. When caught these were nearly colorless, but when exposed to the light in aquaria set before windows in the laboratory they very quickly became pigmented. These were first thought to be the young of the common salamander which had retained their gills over winter, but discussion of the paper elicited the interesting information from Mr. C. S. Brimley that the Marbled Salamander lays its eggs in the fall; these are hatched and the larvæ retain their gills over winter, losing them in the late spring. Some kept by the writer for a month now show only stumps of these structures.

The Gloomy Scale, an Important Enemy of Shade Maples in North Carolina: Z. P. METCALF, Agricultural and Mechanical College, West Raleigh.

This paper summarized very briefly the results of three years' experiments carried on by the State Department of Agriculture for the control of this insect. A brief history of the insect was also given, together with some notes on its present distribution and destructiveness and life history.

To be published in full in the current number of the *Journal of the Elisha Mitchell Scientific Society.*

Two Parasitic Hymenomycetes: GUY WEST WILSON, Agricultural and Mechanical College, West Raleigh.

Attention is called to the attacks of apples in the Piedmont section of the state by *Septobasidium pedicellatum* (Schw.) Pat., which also occurs over a considerable area of the southern states on various hosts. *Fomes roseus* (Albert & Schw.) Cooke is also noted as causing a disease of the red cedar, locally very destructive in eastern North Carolina.

Note on the Fundamental Bases of Dynamics: WM. CAIN, University of North Carolina, Chapel Hill.

Defining mechanics as that science which treats of matter, at rest or in motion, under the action of force; weighing, by both the equal armed balance and the spring balance, is fully discussed and formulas presented. Mass and force are then discussed for both the engineers' and the absolute systems.

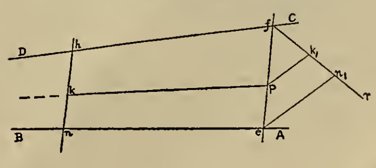
This paper will appear in the next number of the *Journal of the Elisha Mitchell Scientific Society.*

Discovery of Some New Petroglyphs Near Caicara, on the Orinoco: T. A. BENDRAT, University of North Carolina, Chapel Hill.

In the winter of 1908 and 1909, while surveying the region about Caicara, Venezuela, the writer discovered some new petroglyphs, which belong geographically and genetically to the same large group of stone-carvings found scattered over a wide area which is bounded by the Orinoco, the Atabapo, the Rio Negro and the Cassiquiare. While Alexander von Humboldt mentions only two petroglyphs from the region of Caicara, "el sol" and "la luna," of which the writer saw only "el sol," neither he nor any other traveler who ever touched that point seems to have known any of the stone-carvings found by the writer. These newly discovered petroglyphs occur on the banks of the Orinoco and in the adjacent forest. They may be divided up into three distinct groups, one representing the simplest type and consisting of almost geometrical circles, one in the other, the center of the most inner one being hollowed out; another one group of a more complicated type and of more fantastic design, of which only one figure was found; and a third group that evidently represents the highest type in the development of this art of petroglyphy and that comprises "el sol," that was already known to Humboldt, and the new petroglyph that was discovered by the writer, namely, "el tigre." All these petroglyphs are supposed to have been produced in prehistoric times. As to their meaning there exists quite a number of theories. The writer holds the view on the base of extended studies in fetichism that they represent records of earlier and later fetichism, while they have served, at the same time, as an indirect means to develop the art of sculpture that grew out of the art of petroglyphy.

To be published in full in the next issue of the *Journal of the Elisha Mitchell Scientific Society.*

Solution of the Draftsman's Difficulty—To draw from a given point a line which, if extended, would pass through the meeting point of two given lines whose point of meeting is beyond reach: J. F. LANNEAU, Wake Forest, N. C.



Let P be the given point and AB and CD the given lines intersecting at a point beyond reach.

Construction.—Through P draw any line, cutting AB and CD at points e and f; and at some distance from fe, draw hn parallel to fe. Draw fr, at any convenient angle with fe. Take fn equal to hn. Draw Pk_1 parallel to en_1. Lay off nk equal to n_1k_1. Then Pk is the line sought. If produced, it would pass through the distant intersection of AB and CD. (Proof omitted.)

Note.—When the given point P is not between the given lines, the above construction still applies. In this case, put f and h on the line furthest from P.

George Marcgrave, the First Student of American Natural History: E. W. Gudger, State Normal College, Greensboro.

George Marcgrave was a member of the Dutch expedition to Brazil under Johann Moritz, Count of Nassau-Siegen, during the first half of the seventeenth century. He assiduously studied the animals and plants of Brazil during the years 1638–1644. In 1648 his drawings and observations under the title "Historiæ Rerum Naturalium Brasiliæ" were published jointly with the "De Medicina Brasiliensi" of William Piso under the general title "Historia Naturalis Brasiliæ." Marcgrave's part of this work covers 303 folio pages, in which he describes 301 plants with 200 figures and 367 animals, of which 222 were figured. Of these 668 forms practically all were new to science and probably none of the 422 figured had ever been drawn before.

Marcgrave knew nothing of the classification of flowers based on stamens and pistils or of fishes by the count of fin rays, but his descriptions are for the times remarkably clear and his drawings sufficiently exact for the plant or animal to be unmistakably recognized. No country in its early exploration has ever had such a great work published on its natural history.

The full paper will shortly be published in *The Popular Science Monthly.*

Capture of Raleigh, N. C., by the Wharf Rat: C. S. Brimley, Raleigh.

Up to March, 1909, the only species of house rat seen by the author in a residence of over twenty-five years was the roof rat (*Mus alexandrinus*); since then the brown rat or wharf rat (*Mus norvegicus*) has overrun Raleigh, mainly or entirely replacing the former species.

The full data appear in the current number of the *Journal of the Elisha Mitchell Scientific Society.*

No abstracts have been received for the following papers:

"Some Records of Incipient Fern Growth in Carboniferous Time," Collier Cobb, University of North Carolina.

"The Seedling of the Water Oak," W. C. Coker, University of North Carolina.

"Notes on Mutation," W. N. Hutt, State Department of Agriculture.

"The Effect of Temperature on the Contact Resistance of Carbon on Copper," P. H. Daggett, University of North Carolina.

"The Dispensary as a Factor in the Prevention and Cure of Hookworm Disease" (lantern), John W. Ferrell, State Board of Health.

"The Toxicity of Cotton Seed Meal," W. A. Withers and B. J. Ray, with the cooperation of R. S. Curtis and G. A. Roberts, Agricultural and Mechanical College.

"The Walden Inversion," Alvin S. Wheeler, University of North Carolina.

"The Work of the State Laboratory of Hygiene," Director C. A. Shore, Raleigh.

"Some Reduction Phenomena in Hydroids," H. V. Wilson, University of North Carolina.

"Some New Questions Concerning Ventilation," C. W. Edwards, Trinity College.

"The Electrical Resistance of a Flowing Conductor," A. H. Patterson and V. L. Chrisler, University of North Carolina.

"The Water Molds of Chapel Hill, N. C.," W. C. Coker, University of North Carolina.

"Further Notes on the Geology of the Carolina Coast Line," Collier Cobb, University of North Carolina.

"Transient Electrical Phenomena and their Relations to Modern Problems in Electrical Engineering," P. H. Daggett, University of North Carolina.

"The Toxic Action of Hematin and Bile," W. H. Brown, University of North Carolina.

"Notes on the Maturing of Bermuda Grass Seed," O. I. Tillman, State Department of Agriculture.

"Studies of Cottonseed Meal Intoxication as to Pyrophosphoric Acid," W. A. Withers and B. J. Ray, Agricultural and Mechanical College.

E. W. Gudger,
Secretary

State Normal College,
Greensboro, N. C.,
May 13, 1912

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THE RELATION OF ELECTRICAL ENGINEERING TO OTHER PROFESSIONS[1]

On the wall of a great engineering library is the legend "Engineering is the art of organizing and directing men, and of controlling the forces and materials of nature for the benefit of the human race." This is broad and all-embracing, but other professions will find it hard successfully to quarrel with it. While the immediate object of engineering is a material one, engineers draw from many different channels of human energy, such as generalship, commerce, psychology, mechanics, economics, to say nothing of chemistry and physics and many others, all under an interpretation, insight and method that are best described by the term scientific.

It may be asked, Why could not a similar statement of embrasure or scope apply to medicine, the law, the army and other professions? In part it could, but it is to engineering that it applies preeminently. The subject-matter of the older professions, the things about which they busy themselves, and the objects they seek to accomplish have changed relatively little in many centuries. The means have altered but the ends persist. They are approximately the same to-day as they have been throughout history and tradition. With engineering it is different. There was no such profession a hundred and fifty years ago, and if I may a little anticipate my conclusion, there will be no such profession a hundred and fifty years hence in respect to a large part of what we now call engineering.

[1] President's address presented at the twenty-ninth annual convention of the American Institute of Electrical Engineers, Boston, Mass., June 25, 1912.

Such as it is, engineering is embracing an ever-growing horizon, and is including more and more of the activities of civilization. When I say activities I refer to material ones and not to the whole of life itself. The human spirit is the greatest fact in the world, and art and literature that interpret it, the acts of our daily life and our personal relations that depend upon it, religion and the vast body of our social and political experience, that go to constitute life form undoubtedly a mass of activities, which are greater, in terms of consciousness, than the material activities which engineering can affect. In other words, the humanities which have been the same for ages can never be invaded by anything that merely rearranges our relations to the material world.

In the material world, however, which is at once the workshop and the throne, the glory and the limitation of the engineer, marvel has followed marvel and shall be followed by more marvels, for we are beginning to catch the tools' true play; beginning to see the vision of our dominion over the earth. Whether it really is engineering to organize men, to predict the psychology of a fare-paying population, to win the endorsement of a labor union, to treble the yield of a farm by a microscope, all of which successes to-day are called engineering, depends upon the definition that we finally adopt.

It is startling to study the variety and importance of the posts filled by engineers and to note the range of what they do. From the efficiency engineer presenting surprises in the output of a factory where the human factor is large, or the industrial engineer suddenly after thousands of years showing the world how to increase greatly the lay of bricks, or the agricultural engineer working miracles with the soil that for ages farmers have struggled with, to the civil engineer establishing a kingdom and building the Panama Canal, we have instances in which the engineer is doing more and more of the world's work.

The history of this class of men so rapidly growing in numbers, so rapidly differentiating in function is almost a romance. The "Encyclopedia Britannica" names the middle of the eighteenth century—that is, 1750—as the time before which there were only military engineers—who constructed "engines" of war—and it adds that at about that time there began to arise a new class. Little did this new class realize the army it was leading down the industrial paths of time!

The "new class" has surpassed all bounds. From insignificance a hundred and fifty years ago it has increased almost incredibly in numbers and variety of specialization. As a local indication, the Engineering Societies' Building in New York is the headquarters of fifty thousand engineers. As another local indication, the American Institute of Electrical Engineers has in the last ten years increased six fold. The growth in the variety of specialization has been almost as rapid as the increase in numbers. Where there were only military engineers and the "new class" a hundred and fifty years ago, there are twenty-seven recognized varieties to-day. Without mentioning all, they range from civil through mechanical, electrical, mining, illuminating and chemical, to refrigerating, industrial, agricultural and aeronautical. There is even a magazine with the title *Human Engineering*.

A large and increasing part of the capacity of our colleges and universities is devoted to the education of engineers. Parts of the engineering curricula are borrowed for what used to be purely classical courses. The metaphors of the speech of the day often have an engineering basis and—we have a McAndrews hymn. The man in the street knows something about spark plugs, and many women understand the general principles of the telephone. The social status of the engineer has emerged from that of a mechanic to one nearly as high as that of the clergyman, the physician or the lawyer.

Relatively recently there has been going on simultaneously with all this, however, hardly noticed, something else—a vast increase in so-called engineering work by men who are not engineers, and at the same time a large drawing off into executive, administrative, industrial, commercial, civic, educational, financial and even legal callings, of men of engineering training. A history of segregation and disintegration seems to have begun to accompany a history of integration and building up.

For one to say to-day he is an engineer gives very little idea of what he actually does. It does not locate him in one of the twenty-seven recognized classes. It leaves it possible for the hearer to think of him as a "social engineer" or an "efficiency engineer" should he not look like a "civil engineer"; but even if he did define himself and say he was an electrical engineer, the hearer would still not know whether he represented the last word on the loading of telephone circuits or his responsibility was to determine whether the great railroad terminals of Chicago should use a third rail or an overhead catenary. If he should say "I am a teacher," "a physician," "a clergyman," "a lawyer," there would be a much more definite conception attaching to his answer. There must be, therefore, in the title "engineer" something broader, something not included, or included to a lesser degree, in the titles of the other professions or occupations.

A light is shed if we examine the popular definition that engineering is "educated common sense." Can it be that unlike "physician," "lawyer," "teacher," the term "engineer" does not describe what a man *does*, but rather *how* he does it! A method rather than an occupation! It is even so; that is, essentially and with limitations I shall refer to later.

What then is this "method" that has given the engineer his ever broadening domain and brought all kinds of men and callings to his school? He can tell you at once. Here is where he is defined and where his fellows recognize him and each other though they come from the ends of the industrial earth as to diversity of actual occupation. The method had its birth in Greece, though it was stifled almost to death by the tremendous philosophic, humanistic and artistic energies of the Hellenes. Later it was buried in Europe under the irruption of the barbarians. The names of Thales, dear to our profession, with his "elektron," and of Aristotle and Archimedes, stand out as having done much for it—especially Archimedes—in spite of the humanistically polarized intellectual atmosphere in which they lived and which they contributed so gloriously to create.

But the Greeks made only a start. To quote an authority, their material thinking was largely based on what has proved to be a wrong method of procedure, the introspective and conjectural rather than the inductive and experimental. They investigated nature by studying their own minds, by considering the meanings of words, rather than by studying things and recording phenomena. But they saw much of the light with all this. Though absolutely dead for a thousand years in Europe, "the method" was kept alive during the middle ages in Arabia, although confused with magic, alchemy and algebra. Then came Roger Bacon, Leonardo da Vinci and

Copernicus, and science as we know it began to take shape.

Aristotle had sat down in his chamber and he wrote in a book, "A body twice as heavy as another of course falls twice as fast." Galileo released simultaneously from the top of the Leaning Tower a one-pound and a one-hundred-pound shot and they reached the earth together, before the eyes of the assembled University of Pisa. But "the method" was repugnant to the university, and almost to a man they believed their Aristotle, sophistically explained away what they saw, and persecuted Galileo. Descartes, Newton, Lagrange, Laplace, Francis Bacon connote to engineers the transcendent story, unless for electrical engineers there should be added Ampère, Faraday, Henry, Helmholtz, Kelvin.

The method of doing things that makes an engineer is, therefore, the applying to practical and utilitarian ends the principles and reasoning of science. Engineering is not science, for in science there is no place for the conception of utility. Truth is her sole criterion. In the exalted language of Professor Keyser, "Not in the ground of need, not in bent and painful toil but in the deep-centered play-instinct of the world science has her origin and root; and her spirit, which is the spirit of genius in moments of elevation, is but a sublimated form of play, the austere and lofty analogue of the kitten playing with the entangled skein or of the eaglet sporting with the mountain winds."

Engineering is science's handmaid following after her in honor and affection, but doing the practical chores of life, concerned with the useful and the material; with costs and with expediency, and concerned with the humanities only in so far as they are an incident in some particular scheme of reality, and then objectively, if that may be said. Her methods merely apply straight thinking to material problems for useful purposes.

Does this constitute a profession? No. Some day it will be the way almost everybody thinks instead of a body of specialists and then the difference between a doctor, for instance, and an engineer, will be only in the things they busy themselves about; as is to-day the only difference between kinds of engineers.

The center of education has been shifting rapidly recently—almost as rapidly as material well being has been increasing. The application of science to living has marked an age as distinct as the age of the climax of art in Greece. The "new class" has been but a pioneer in sowing the seeds of scientific rationalization in a field the value of which was only dreamed of by Archimedes and not actually recognized until, as the encyclopedia tells us, "about the middle of the eighteenth century," when the "new class" began to arise. And now, as to the limits within which engineering is a method rather than an occupation.

There will always be engineers, for the methods of science will constantly advance, and there will be needed continually, to interpret and transmit them to mankind, and to make the first applications of them to useful purposes, a class of men who, by instinct and taste, as well as by the possession of what I later shall call the dynamic component, find easier than other men—and consequently perform better—the kind of scientific thinking, observation and action that characterize engineers to-day.

What these men will be busy about it is hardly safe to say, although it is probable the present great divisions of engineering will be more or less preserved. It seems certain that a large mass of knowledge that now is called engineering and forms the basis of many of the engineering specializations, will become general knowledge, and will be absorbed by the community, partly as a result of the shifting of the center of education and partly through every-day familiarity, and the men possessing this knowledge will no longer be called engineers. They will be called farmers, let us say, in the case of the "agricultural engineer"—of course, a farmer of a very advanced kind compared to the earlier one.

But the center of education will not always continue to shift. It is shifting now only because it has so long been eccentric. It would be a calamity for it to shift too far, resulting in a world whose sole training was applied science and the utilities. Under such a condition, engineering and the utilities themselves would languish instead of flourishing, for there would be lacking in engineers the dynamic component.

Ample knowledge, insight, information does not make an engineer. He must first be a man. Engineering is not thought like philosophy; it is thought times action, and only when the qualities of action are developed approximately to the same extent as the qualities of thought is an engineer at his best. Only then is his area of effect a maximum. The qualities of action involve tastes and personality, the feelings, the will. And it is these that constitute the component or factor that makes an engineer's intellectual or rationalizing equipment dynamic—that puts it to use.

It was partly the intense appreciation of the value of the dynamic component that led the Greeks and successive centuries astray in the direction of their education and contributed to an underestimate of the importance of science and the study of the laws of nature. We must not go to the equally wrong other extreme.

So far I have said but little of electrical engineering. It must be brought in if for no other purpose than to justify our title. Although the article on "Engineering" in the "Britannica" occupies only six inches of one column, it concludes with the following: "The last great new branch is *electrical* engineering, which touches the older branches at so many points that it has been said that all engineers must be electricians." If engineering is a method of doing things, and electrical engineering tends to embrace all other branches, there is an implication that electrical engineering is the latest or most highly developed form of the method—the method that is the utilitarian application of the principles of science to the material facts of life.

Such is unquestionably the case. Born scarcely more than twenty-five years ago, the "youngest branch," electrical engineering, had the opportunity of striking its roots into the richest of scientific soils, free from prejudices, customs or traditions. It had no entangling alliances, no political laws to retard or encumber it. The field it preempted was the terra nova of engineering, the new world of applied science.

Under the influence of those geniuses of science, Volta, Faraday, Ampère, Ohm, Kelvin, Helmholtz, Maxwell, Oersted, Henry, and with the metric system for its cornerstone, there developed a comprehensive structure of thought and a related scheme of units. The latter are the admiration of the world for their simplicity, their convenience, their precision and their reproducibility. The scientific method as applying to all phenomena acquired its most perfect embodiment in the electric system and its relations.

But there is a philosophical debt that we electrical engineers owe our units. They school our minds. The ability to measure with precision difficult and complicated quantities enables clear thinking on them and renders reasoning about them possible that otherwise could not be attempted. To name a thing is to know it. The wonderful electrical units are a fluent language that gives the widest opportunity to thought. By their character they educate our faculties of definition and of relation. They typify all quantitative thinking, not merely electrical. They are the epitome, the last word of the great minds of our age, as to what the scientific method of thought is, in relation to the whole realm of matter and force.

Therefore although the subject matter of electrical engineering is covering a wider and wider range—so wide as to be almost incongruous—the electrical method of thinking is applicable throughout. It is spreading far beyond. As an electrical engineer, I even find myself thinking of the crowds passing in the streets in terms of amperes and volts, and of the fluctuations of the stock market in terms of current, inductance, capacity, resistance and resonance.

That which can impose form upon our thought enables us successfully to think of any kind of thing. The forms of thought established for electrical engineering are at once so comprehensive, so rigid, so rich in detail, and so illuminating that engineering does not bound them. They may be called the manifestation of science in civilization, the best representation of the scientific method at work for utilitarian ends. They prove that the profession of electrical engineering not only deals with single-phase motors, storage batteries, high-tension transmissions, turbo generators, coronas, carbon transmitters and commutation, *as an occupation,* but that it also is a *way of thinking,* and as such is not an occupation, but the latest and most highly developed scientific method of solving all kinds of practical problems of matter and force, for the benefit of the human race.

Gano Dunn

HONORARY DEGREES AT THE UNIVERSITY OF MICHIGAN

On the occasion of the celebration of the seventy-fifth anniversary of the University of Michigan honorary degrees were conferred by vote of the senate council and board of regents on graduates of the university and former members of the university senate. The doctorates conferred on scientific men with the accompanying remarks were as follows:

THE DEGREE OF DOCTOR OF SCIENCE

Edward Allen Fay, of the class of 1862, educator, editor, one of the foremost Dante scholars in this country and historian of American schools for the deaf.

Doctor John Elmer Weeks, of the class of 1881, department of medicine and surgery, now professor of ophthalmology in New York and Bellevue University, joint discoverer of the Koch-Weeks bacillus.

Doctor John Jacob Abel, of the class of 1883, professor of materia medica and therapeutics in the department of medicine and surgery of this university from 1891 to 1893, now professor of pharmacology in Johns Hopkins University, distinguished for his researches and original contributions.

Doctor Henry Sewall, professor of physiology in this university from 1882 to 1889, now professor of physiology in the University of Colorado, whose research on immunization to the venom of the rattlesnake done while a professor in this university laid the foundation for the discovery of diphtheria antitoxin.

Bryant Walker, of the class of 1876, a man who, though a busy lawyer, has found the time to make himself well and favorably known for his published work on molluscs, a world authority on the group.

Charles Francis Brush, of the class of 1869, department of engineering, the earliest pioneer in the field of electric lighting, inventor of modern arc electric lighting, honored many times at home and abroad for his scientific achievements.

THE DEGREE OF DOCTOR OF ENGINEERING

George Henry Benzenberg, of the class of 1867, department of engineering, past president of the American Society of Civil Engineers, a noted authority on the construction of water works, distinguished civil engineer and citizen.

Cornelius Donovan, of the class of 1872, department of engineering, a profound student of river hydraulics, a faithful servant of the United States government for thirty-eight years, and distinguished as the builder of the great jetties at the mouth of the Mississippi River.

THE DEGREE OF DOCTOR OF LAWS

Doctor William Henry Howell, of Johns Hopkins University, professor of histology and physiology in the University of Michigan from 1890 to 1892, distinguished teacher and investigator, a physiologist of the first rank.

Professor Andrew Cunningham McLaughlin, of the class of 1882, for many years a member of the historical staff of his alma mater, now professor and head of the department of history in the University of Chicago, a distinguished teacher whose published contributions have placed him in the front rank of American historical scholars.

Doctor James Playfair McMurrich, for thirteen years professor of anatomy in the University of Michigan, now professor of anatomy in the University of Toronto, distinguished as a teacher and for learned contributions to the sciences of biology and anatomy.

Henry Smith Carhart, for over twenty years professor of physics in the University of Michigan, now a worthy recipient of the honors of the Carnegie Foundation, distinguished as scholar and author and for his service in the cause of international electrical units and standards of measurements.

Robert Simpson Woodward, a graduate of the University of Michigan in the class of 1872, since 1905 the president of the Carnegie Institution of Washington, engineer, astronomer, geographer, physicist, a renowned investigator of problems in the solution of which the whole world is interested.

THE FUNERAL OF M. POINCARÉ

The funeral of M. Henri Poincaré took place on July 19. After religious ceremonies at the church of Saint-Jacques-du-Haut-Pas the procession passed to the cemetery of Montparnasse, where eulogies were delivered by the minister of public instruction, speaking for the government and the university, M. Claretie for the French Academy, M. Appell for the Faculty of Science, by M. Bigourdan for the Bureau of Longitudes, by M. Painlevé for the Academy of Sciences and General Cornille for the Polytechnic School. From *Nature* we learn that the pall-bearers were MM. Guist'hau, minister of public instruction, Jules Claretie, Lippmann, Appell, Bigourdan, General Cornille, Painlevé and Zeiller. The hearse was covered with wreaths which had been sent by the staff and teachers of the Ecole Polytechnique, the Faculty of Science, the French Physical Society, the Observatory of Meudon, the Association of Pupils and Past Pupils of the Faculty of Science, the General Association of Students, the French League of Moral Education, etc. The chief mourners were MM. Léon Poincaré, son of the deceased; Emile Boutroux, his brother-in-law; Raymond Poincaré, President of the Ministerial Council, and Lucien Poincaré, Director of Secondary Education and Minister of Public Instruction, his cousins. There were also present: Captain Grandclément, representing the president of the republic; MM. Antonin Dubost, president of the senate; Klotz, minister of finance, and Lebrun, minister for the colonies; the representatives of the president of the chamber, MM. Steeg, Fernand David, Briand, Jean Dupay, Pams, René Besnard and Léon Bérard, members of the government; the delegacy of the French Academy, consisting of MM. Jules Claretie, director; Henri Roujon, treasurer; Thureau-Dangin, permanent secretary; Denys Cochin, the Marquis de Ségur, Masson, and Marcel Prévost; the delegacy of the Academy of Sciences, consisting of MM. Lippmann, president, Darboux and van Tieghem, permanent secretaries; Émile Picard, Painlevé, Humbert, members of the section of geometry; the members of the higher council of public instruction, the members of the council of the university; the delegacy of the professors of the faculty of science, consisting of MM. Andoyer, Goursat, Kœnigs, Abraham, Cartan, Borel, Pinseux, Houssaye and Perrin; a delegacy of members of the corps des mines, of the bureau des longitudes, of the association of pupils and past pupils of the faculty of science; Sir J. Larmor, senior secretary, and Mr. Dyson, representing the Royal Society of London; the mayor and the deputy-mayors of the fifth arrondissement; the Prince of Monaco, Prince Roland Bonaparte; MM. Liard, vice-rector of the University of Paris; Baillaud, director of the Paris Observatory; Deslandres, director of the Observatory of Meudon; Mgr. Duchesne, director of the École Française de Rome; Paul Hervieu, Henri de Régnier, Louis Passy, Joseph Reinach, Georges Perrot, René Doumic, Mmes. Milne-Edwards, Émile Ollivier, Professor Hutinel and others.

SCIENTIFIC NOTES AND NEWS

The following lectures will be delivered at the International Congress of Applied Chemistry to be held in New York in September: "The Rôle of the Infinitely Small in Biological Chemistry," by M. G. Bertrand, of Paris; "Oxidation of Atmospheric Nitrogen in Norway," by Dr. S. Eyde, of Christiania; "The Most Recent Problems of Chemical Industry," by Dr. C. Duisberg, of Elberfeld; "Permanent Fireproofing of Cotton Goods," by Professor W. H. Perkin, F.R.S., of Manchester; "Synthetic Ammonia," by Dr. H. A. Bernthsen, of Ludwigshafen; "The Photochemistry of the Future," by Mr. G. Ciamician, of Bologna, and "Priestley in America," by President Ira Remsen, of the Johns Hopkins University.

Professor von Wassermann has been appointed head of an institute for experimental research on cancer established by the Kaiser Wilhelm Society for the Promotion of Science.

The Vienna Academy of Sciences has conferred its Lieben prize for 1912 on Dr. Oswald Richter for his work on the food of algæ.

The medal of the Royal Bavarian Academy of Science has been awarded to Dr. C. C. Hosseus, of Berchtesgaden, for his journey in Siam.

The Schaudinn medal has been awarded to Dr. Chagas, of the Institut Oswaldo Cruz, at Rio de Janeiro, for his discovery of the trypanosome responsible for epidemic thyroiditis.

Professor Carl Binz, formerly director of the Pharmacologic Institute at Bonn, celebrated his eightieth birthday July 1.

In the geological survey at Berlin, Drs. Oskar Tietze Wilhelm Wunstorf and Leo Siegert have been promoted to be geologists.

Col. William C. Gorgas has declined the invitation to become chairman of the Boston Board of Health.

Dr. Alexander N. Winchell has resigned from the United States Geological Survey in order to resume work as a consulting mining geologist. He has recently returned to his office in Madison, Wisconsin, after spending several weeks in Nevada in connection with litigation regarding the ownership of the ore deposits of the national mine in that state.

Assistant Dean W. T. Bawden, of the College of Engineering of the University of Illinois, has resigned and will take up special graduate work at Teachers College of Columbia University in education.

Dr. Edwin D. Starbuck, professor of philosophy in the State University of Iowa, has been granted sabbatical leave for the coming year, and will reside in Boston. He will act for the year as psychologist adviser to the *Beacon Press* in the publication of children's and young people's literature, and especially in the formation of the graded Sunday-school curriculum.

Professor William S. Dietrich, head of the division of swine husbandry at the University of Illinois, has resigned to become superintendent of a stock farm.

Dr. Mel. T. Cook, professor of plant pathology at Rutgers College, gave a lecture before the students at the Biological Laboratory of Cold Spring Harbor, L. I., on the "Immunity of Plants to Disease," on July 29, 1912.

Dr. E. F. Bashford, director of the Imperial Cancer Research Fund, will deliver the von Leyden memorial lecture in Berlin on October 21. As already announced he will give the Middleton Goldsmith lectures before the Pathological Society of New York on October 2, 3 and 4.

Professor Theobald Smith, of Harvard University, gave his last lecture as visiting professor to the University of Berlin on June 23.

The presidents of the Royal Society and the Royal College of Surgeons some weeks ago took the necessary steps for the formation of a large and representative committee for the purpose of establishing a memorial to the late Lord Lister. A meeting of this committee, which was largely attended, was held on July 22 at the rooms of the Royal Society, under the chairmanship of Sir Archibald Geikie. The following were appointed an executive committee to recommend to a future meeting of the general committee a scheme for the memorial to Lord Lister and to organize an appeal for subscriptions: The Archbishop of Canterbury, the Lord Chancellor, Lords Iveagh, Rayleigh, Rothschild and Alverstone, the dean of Westminster, the Lord Mayor, the Lord Provosts of Edinburgh and Glasgow, the Master of the Rolls, Mr. Lewis Harcourt, M.P., Sir T. Barlow, Sir W. W. Cheyne, Sir R. J. Godlee, Sir H. Morris, Sir A. Geikie, Sir D. MacAlister, the Hon. Sir C. Parsons, Sir W. Turner, Sir J. Wolfe-Barry, Sir J. R. Bradford, Sir A. P. Gould, Sir A. Kempe, the Hon. W. F. D. Smith, Mr. F. M. Fry and Mr. Edmund Owen. Lord Rothschild and Sir W. W. Cheyne were appointed treasurers and Sir J. R. Bradford was appointed secretary of the Lister Memorial Committee.

A tablet is to be erected at the University of Liverpool in memory of the late Sir Rubert Boyce.

A committee has been organized to erect a monument to J. Janssen, the astronomer and astrophysicist, the founder of the observatory on the summit of Mont Blanc.

At a meeting of the French Academy on July 17 M. Jules Claretie, who presided, delivered an address in memory of M. Henri Poincaré. The meeting then adjourned as a tribute of respect.

Mr. James Dunn, a distinguished British naval architect, died on July 17, aged seventy-five years.

The death is also announced of Mr. Andrew Lang, known for his contributions to anthropology and eminent for his literary and critical work.

Dr. Johannes Chatin, professor of histology at Paris, has died, aged sixty-five years. He was the son of the celebrated botanist, Gaspard-Adolphe Chatin, and was known for his work on comparative anatomy and helminthology.

Dr. Ludwig Ganglbauer, director of the zoological department of the Royal Natural History Museum at Vienna, died on June 5.

The United States Civil Service Commission announces an examination to fill a vacancy in the position of assistant physical geologist, Geological Survey, Washington, D. C., at an entrance salary of $1,500 per annum; metallographist in the Bureau of Standards at a salary of $1,800 per annum; pomologist in the Bureau of Plant Industry, at a salary of from $1,800 to $2,500 per annum, and assistant dairyman qualified in creamery operation and butter making, at $1,500 to $1,740 per annum, in the dairy division, Bureau of Animal Industry.

The ninth International Congress of Zoology is to be held at Monaco from March 25 to 30, 1913.

The *Journal* of the American Medical Association states that the preliminary program of the Pellagra Conference which is to be held in Columbia, S. C., October 3–4, includes an address to be given by Surgeon-General Rupert Blue; a preliminary report by the Thompson-McFadden Commission on Epidemiology of Pellagra, and other papers dealing with the prevalence, geographic distribution, artificial production and other subjects of general interest in regard to this wide-spread disease.

The new Hamburg Observatory built on the Gojenberg, near Bergedorf, of which Professor Scharr is director, has been dedicated.

It is proposed to acquire the estate of Corstorphine Hill as the site of zoological gardens for Edinburgh at a cost of $85,000.

On July first, the beginning of the fiscal year for the University of California, the property and general management of the Marine Biological Station of San Diego passed formally into the hands of the regents of the university, and hereafter the station under the new name, The Scripps Institution for Biological Research of the University of California, will be a department of the university. All details of management and determination of scientific policy will, however, be by a local board at San Diego. Miss Ellen B. Scripps, already a benefactor of the institution to a large amount, has signified her willingness to add liberally to her gifts, and new developments will be begun at once. Additions to the library, a wharf, the salt water pumping plant and housings for those connected with the laboratory, will be provided as rapidly as the plans can be perfected. As a step preparatory to the new work a survey of the 100-acre tract of land owned by the institution, and on which the laboratory stands, will be made for the purpose of laying out roads and locating the sites of the projected dwelling houses.

News reached Copenhagen early in May, as we learn from the *Geographical Journal,* of the arrival at Maskat of Mr. Barclay Raunkiær; a Danish traveler, who set out for that country in November, 1911, under the auspices of the Royal Danish Geographical Society. The explorer traveled from Aleppo *viâ* Baghdad to Basra, which he reached on January 22. From Koweit (where he was well received by the regent) his intention was to go south to Riad in the Wahabi country, and thence to make his way back to the Persian gulf by an eastward route through the Hofuf oasis. According to the preliminary announcement he appears to have successfully carried out this program, and to have secured valuable anthropological, zoological and botanical observations, besides mapping the country traversed. Mr. Raunkiær is known as a writer on the geography of plants, and for a previous journey made by him in Central Tunis.

The volcanoes of Alaska are not all dead, and those that smoke are held in dreadful awe by the natives. As late as 1883 Mount Augustine, a volcanic cone which rises 4,000 feet out of the waters of Cook Inlet, was in violent eruption, and Mount Iliamna and Mount Redoubt, about 10,000 feet high, towering above the coast range, were in eruption in 1854 and 1902, respectively. Lake Iliamna is the largest freshwater body in Alaska. It is 80 miles long by 8 to 20 miles wide—somewhat larger, perhaps, than Long Island Sound. Its bottom is far below sea level. The altitude of its surface is only 50 feet above the ocean, but soundings at its upper end indicate a depth of many hundred feet. North of and tributary to Iliamna Lake is Clark Lake, more than 50 miles long, but narrow. This lake is 220 feet above the ocean tides, but in places is more than 600 feet deep. The region containing these volcanoes and lakes was the scene of very early missionary endeavors and trade exploitation by the Russians. Nevertheless little exact knowledge of the region has been acquired, and that has been largely inaccessible to the public, so that the recent investigations by the United States Geological Survey, a report of which has just been published as Bulletin 485, entitled "A Geological Reconnaissance of the Iliamna Region, Alaska," by G. C. Martin and F. J. Katz, should be very welcome. This report describes the geographic and geologic features and the mineral resources of an area covering more than 5,000 square miles lying west of Cook Inlet. It discusses the mountain systems, the lakes, rivers and glaciers. The climate and vegetation, particularly the distribution of forests and the cause of the limits of the forests, are considered. Transportation routes are indicated. The geology is treated at considerable length, and so also the prospective mineral resources, which are copper, gold, silver and petroleum. None of these minerals have yet been shipped from this district, but the region may neverthless some day become important commercially. The report should be of value to those who are interested in the mineral prospects and to those who intend to search for similar deposits in other parts of the district, as it describes the known mineral deposits and the geology of the region containing them. The report is accompanied by topographic and geologic maps in colors on a scale of 4 miles to the inch and by numerous smaller maps, sections and views.

UNIVERSITY AND EDUCATIONAL NEWS

The sum of £3,000 has been left to the University of Belfast by Mrs. F. Magrath for the foundation of a "Magrath clinical scholarship," to be given for proficiency in reports of bedside cases open to fourth-year medical students.

At an extraordinary meeting of the senate of the University of London, held on July 17, resolutions were adopted, as we learn from *Nature*, approving of the Foundling Hospital site in Bloomsbury for the proposed new headquarters for the university, in accordance with the recommendations contained in a report of the Special Sites Committee, over which Sir Philip Magnus, M.P., presides. Representations are to be made to the government with the view of obtaining support for the scheme, and the Drapers' Company are to be asked whether they consider the site suitable for the proposed Senate House which they have offered to provide at an estimated cost of £60,000. Lord Haldane is also to be asked to use his influence so that offers of financial support already made to him may be available for the Foundling Hospital site. A motion to refer back the report for further consideration was negatived by a small majority.

Mr. H. G. Hartmann, Ph.D., of Columbia University, has been appointed instructor in philosophy at the University of Cincinnati.

George Weatherworth Stratton, B.A. (Colorado), Ph.D. (Ohio State, '12), has been appointed assistant professor in the department of chemistry of the University of Kansas.

Dr. Otto Porsch has been promoted to be associate professor of botany and director of the botanical garden of the University of Czernowitz.

DISCUSSION AND CORRESPONDENCE

ZOOLOGICAL NOMENCLATURE

Many zoologists have long been exasperated by the changes of familiar names which result from a blind and inflexible following of the law of priority. The conditions, in fact, are so bad that it is a frequent remark that the only fixed names are the common ones. At the Graz Zoological Congress there was an attempt to have the rules modified and to introduce a little equity and common sense into the nomenclatorial laws, but, although the movement was backed by a majority of those present, it was burked in the nomenclatorial commission.

Recently a number of Austrians (among them the well-known names of Hatschek, Steindacher, Grobben, Sturany, Graf Attems, Przibram, etc.) have formulated three proposed modifications of the laws and rules to which they wish all who favor them to subscribe. In the same line is the recent action of the German Zoological Society, which at the Halle meeting adopted three articles which are to be presented at the next (Monaco) meeting of the Zoological Congress to be held in March, 1913. The circulars of both organizations are summarized here. The undersigned will supply copies of the original circulars to all asking for them as long as the supply lasts.

The first section of the Austrian circular modifies article 25 of the International Code and provides that no work which is not binomial in character shall be considered in the nomenclature of genera and species. The second provides that when a species has once been removed from a genus it shall not be considered as the type of the genus in any later revision. This will avoid the most flagrant cause of generic changes and its adoption will allow the retention of the great majority of the familiar names.

The third section is for the government of the Commission on Nomenclature. It provides that all propositions for alterations of or additions to the Rules of Nomenclature which have received an absolute majority of the full membership of the Commission on Nomenclature (*i. e.*, 8 votes) and of the votes of those members who are present at the voting on the proposition at the meeting of the Congress, shall be submitted to the plenum of the Congress for vote.

This last is of great importance since the existing rule (*adopted by the Commission and not by the Congress*) demands the unanimous consent of the Commission before any proposition can be submitted to the Congress; thus allowing a single member of the Commission to overrule the great majority of the zoologists of the world, a contingency which, in the light of some recent occurrences, is not beyond the realms of imagination.

All who are in favor of these modifications are earnestly requested to sign a statement to the effect that they endorse the three propositions of the Committee signed by O. Abel and others, and to send the same to Professor F. Poche, Wien, I, Graben 17, Austria.

The German Zoological Society also adopted three propositions, as follows:

I. Following the example of the botanists, lists of generic names are to be prepared which are to be removed from any action of the law of priority, are never to be changed nor transferred to other genera. These lists are to be increased by special commissions. Prominent among these are the names which were in common use before 1900 and which are employed in instruction. Among these may be cited the following as examples:

MAMMALS

Anthropopithecus, chimpanzee (not *Simia*, orang).
Cercolabes (not *Coendu*).
Caelogenys (not *Agouti*).
Cynocephalus (not *Chaeropithecus*).
Dicotyles (not *Tayassus*).
Echidna (not *Tachyglossus*).
Galeopithecus (not *Cynocephalus*).
Lemur (not *Procebus*).
Manatus, manatee (not *Trichechus*, walrus).

BIRDS

Cypselus (not *Apus*).

REPTILES

Coluber (not *Elaphe*).
Trionyx (not *Amyda*).
Tropidonotus (not *Natrix*).
Vipera (not *Coluber*).

FISHES

Amia (not *Amiatus*).
Bdellostoma (not *Heptatrema*).
Conger (not *Leptocephalus*).

TUNICATA

Cyclosalpa (not *Holothuria*).
Salpa (not *Dagysa*).

INSECTA

Anthophora (not *Podalirus*).
Periplaneta (not *Stylopyga*).

CRUSTACEA

Apus (not *Triops*).
Astacus (not *Potamobio*).
Daphnia (not *Daphne*).
Homarus (not *Astacus*).

HIRUDINEI

Clepsine (not *Glossiphonia*).

MOLLUSCA

Octopus (not *Polypus*).
Unio (not *Lymnium*).

BRACHIOPODA

Terebratula (not *Liothyrina*).

ECHINODERMA

Holothuria (not *Bohadschia*).
Moira (not *Echinocardium*).
Colochirus (not *Actinia*).
Schizaster (not *Spatangus*).
Spatangus (not *Prospatangus*.)
Strongylocentrotus (not *Echinus*).

PROCHORDATA

Phoronis (not *Actinotrocha*).

CNIDARIA

Actinia (not *Priapus*).
Physalia (not *Holothuria*).

II. The transfer of generic or specific names from one genus or species to another shall not be allowed, when this will lead to lasting confusion or error.

III. Certain works are not to be considered in the determination of questions of priority. Among these are:

P. H. G. Moehring: "Geschlechten der Vogeln, Avium genera. Übersetzt von Nozemann." 1758.
Gistel: "Naturgeschichte des Tierreichs." 1848.
Meigen: "Nouvelle classification des mouches à deux ailes (Diptera)." 1800.
Frisch: "Das Natur-System der vierfüssigen Tiere." 1775.

Brisson: "Regnum animale in Classes IX distrib." 1762.
Brunnich: "Zoologiae Fundamenta praelectionibus academicis accommodata." 1772.
Gronovius: "Zoophylacii Gronoviana Fasciculus I." 1763.
Gronovius: "Zoophylacium Gronovianum," etc. 1781.
Geoffrroy: "Histoire abregée des Insectes, etc." 1762.
"Museum Calonnianum." 1797.
Okén: "Lehrbuch der Naturgeschichte." 1816.

This list will be enlarged by the commission.

IV. Also, in determining matters of priority, certain other publications shall be ignored, among them articles in encyclopedias, popular works of travel, journals of hunting and fishing, catalogues, garden journals, agricultural periodicals, political and local newspapers and other non-scientific journals which are without influence in systematic science.

Those who are willing to subscribe to these additions and emendations of the nomenclatorial laws are earnestly requested to sign and send to Professor Dr. A. Brauer, Zoologisches Museum, Invalidenstrasse, Berlin, Germany, a postal card to the effect "I am in sympathy with the propositions of the German Zoological Society to restrict the law of priority and authorize my name to be appended to them."

It is hardly necessary to add anything to the matters referred to above. A single glance at the list of generic names which it is proposed to have removed from the rules will convince any one that the changes otherwise necessary would result in endless confusion without a single gain to science. The other proposals also will appeal to all who are not firmly wedded to an inflexible law with all the deplorable results that must follow. It is only by having many names appended to the proposals that the changes can be carried through the next congress. It is to be regretted that the time selected for the Monaco meeting is such that most Americans will be prevented from attending, but this has seemed necessary from the matter of climate and the times of the European vacations.

J. S. Kingsley

DOME THEORIES AS APPLIED TO GULF COAST GEOLOGY

To the Editor of Science: In a recent number of Science (June 21) is found a communication by Captain A. F. Lucas in which he states without any qualifications that the undersigned "claims the entire credit for the discovery and promulgation of 'the dome theory' of the accumulation of oil in the Gulf Coastal Plain." The statements are found so "misleading" that he feels it his duty to correct them. This he endeavors to do by quoting the article in full and following the same by quotations from those familiar with oil development along this coast.

The misinterpretations the Captain has put upon my article seem to have their origin in our different conceptions of what is implied by a "dome theory." That various theories at various times, each with some excellent and some weak points, have been suggested to account for the dome structures of our coast we know full well. But that there is an acknowledged one styled "the dome theory" is news to the undersigned. That this writer does claim the credit for the discovery and promulgation of "a dome theory" he will have to admit. Others will have to make similar admissions. Even the Captain mentions entering Texas with a "nascent dome theory" in his mind. Possibly this one after successful birth has grown into "the dome theory." However, judging from the tenor of the Captain's article, including quotations, it seems that the phrase, "the dome theory," has often been used to imply simply short anticlinal or quaquavasal structures with local oil concentrations. If such be the general acceptation of the phrase then the writer must frankly admit that the "credit for the discovery and promulgation of" the dome theory of the accumulation of oil in the Gulf coastal plain is not his. The tendency of hydrocarbons to accumulate in anticlines, long or short, was a well-known fact long before the development of the coastal oil fields. That the coastal plain contained structural irregularities—as at Sulphur—was early discussed by Hilgard, as all students of Louisiana geology must admit. The idea was temporarily discounted by some subsequent writers who saw no signs of structural complications at the surface. The drill has settled all this. What the nature or origin of such irregularities really was as hinted at by Captain Lucas in the expression "nascent dome theory" we have little from his pen to indicate. Some said afterwards that his ideas were thus and so; even the Captain seems now to prefer to quote from these sources rather than from contemporary statements of his own. However, to Captain Lucas belongs the credit of not only believing that something worth while was under Spindletop (as Higgins did ten years before) but of influencing capital to go in with him in making a thorough test (for sulphur?).

In studying the geology of the coastal plain for some ten or a dozen years the writer has had occasion not only to learn what others have thought as to the origin of those remarkable coastal structures, but to make observations and collections in the field for himself. He too has proposed a "nascent" or at least an embryonic dome theory (not claiming it as "the dome theory") whereby the "movement upwards of huge masses of rock salt," etc., must produce structures, not only of the well-known inverted saucer-shape at top, but of upturned, pinched out, slickensided beds along their flanks. All these when there is an alternation of pervious and impervious beds may aid in oil concentration. Lateral or flank oil, in contradistinction to crest oil as at Beaumont, is well known at Anse-la-Butte, Vinton and now at Pine Prairie and doubtless occurs in paying quantities at Belle Isle, Sulphur and many other domes. The insistence by the writer on the proper locations for oil in the "flank" condition is what the director of the Myles Mineral Co. had in mind when he wrote:

I consider this a most remarkable vindication of a theory originated by you and we attribute a large measure of success thus far to your advice.

With all the above facts in mind the undersigned still sees no harm in referring to the workings of his own dome theory, provided he labels it as such—as he did. Nor can he see how such references can in any way detract from the credit due Captain Lucas for his views on dome structure—whatever they were.

As a parting shot the Captain calls attention to my incompetency in "locating wells" because the Producers well at Pine Prairie "failed to produce." Allow me to state I had no hand in its location. It is too far away from the flanks of the dome for any economic results. So far, the locations I have approved have yielded oil or gas or both in fair quantities. Can others say more?

G. D. Harris

Pine Prairie, La.,
June 29, 1912

UNIVERSITY CONTROL

LETTERS FROM CORNELL UNIVERSITY

It is certainly curious, to say the least, that in a democratic country we should have developed what is apparently a monarchical system of university government, whereas in monarchical countries they have democratic systems of university control. However, I doubt whether the government of American universities is really as monarchical as it sounds, or as the organization would suggest. Of course, there are good systems of government and bad systems of government as such, but the success of any system depends in the end largely on the personality of the members of the board and of the president. It is possible to work out a thoroughly democratic system even under the monarchical form that we have established in this country. I am afraid that a discussion of this question is likely to be largely academic, for I do not see any reason for thinking that we shall be able to make any radical departures in the general philosophy of the administration of our institutions. In the case of state institutions particularly, the representatives of the people must in some way have charge of the institution; and this of itself throws the organization of the governing board into one of three or four alternatives. I am afraid myself that the plan that you have proposed would in the end prove to be too complicated, although it seems of itself to be simple. The general tendency in our busy American life is that persons will delegate their authority and their responsibilities to persons who are willing and in position to take them. My own feeling is that we must accept the general block outline of the American system, and then make changes here and there, but more particularly try to develop a better spirit of cooperation and correlation between all parts of the institution. For myself, I think that the developing of this new spirit is really the keynote to the whole situation. I think this can be developed by free public discussions of all the questions involved, just such as you yourself are making. I should not myself be so much interested in any scheme as I would to put before the college and university people of the country a dignified series of discussions, running over a series of years, that would uncover the weak spots and the inefficient and domineering practises that are likely to result in the American systems. I think that we should soon find ourselves able to distinguish four or five cardinal principles around which we could group all the varying opinions and that we could make very great progress toward the development of a greater cooperative responsibility on the part of all persons who are parts of the institutions.

(1) I am afraid that this is not feasible. I doubt whether the professors would pay dues. As you yourself point out, there are special difficulties in the case of state institutions. (2) Not feasible. The president has to travel and entertain in a way that the professor does not. He can't do this unless he has a larger salary directly or indirectly. (3) Sound. (4) Sound, except that it makes no provision for a department which has run down and which really needs reorganizing. Of course the members of the department are outvoted two to one, but I am not certain how it would work. While the principle of equal salaries is good, I don't know whether the average university would not be handicapped under it. (5) Sound. To my mind the worst feature about the university situation is that the president is the only man who explains the views of the faculties to the trustees and *vice versa*. No man can do that fairly. There ought to be at least two other members of the faculty on the board of trustees. This would be an easy reform to put through and would eliminate many, though of course not all, of the present difficulties.

While I agree with the main principles of your proposition for university control, I could not agree with all its details. I am heartily in accord with your proposition to limit the activities of the American university president, particularly with reference to the appointments of professors and to their tenure of office. At the same time it seems to me that there is need of a more centralized organization than your plan proposes. There surely seems to be need of a competent executive, and in private endowed institutions there has apparently been justification for the view that there is need of an executive who can also secure funds for the university. It is my feeling that the activities of the American university president should be distinctly curtailed, and that he should receive supervision on the faculty side as he has on the trustee side, but I am not of the opinion that the office should be abolished. I believe the evils that have crept into the system can be amply checked by very light modification in existing conditions.

In university control the wisdom of having both a chancellor and president is questionable. Although separate duties and qualifications may be required of each, there would doubtless arise occasion where there would be an overlapping of function, giving rise to divided authority and divided responsibility. This usually means less harmony and less efficiency. The university executive should possess high educational and business standards. Not all of the university's business is done through the treasurer's office. In this modern age why should not education and business go hand in hand? Some universities have been able to demonstrate that it can be done. If there are peculiar and exacting qualifications demanded of the executive, it is only fair that there should be greater compensation. In some universities a certain number of the alumni are elected to the board of trustees by their fellow alumni. Why should not the faculty elect a certain number of their members to the board? Is there any other group in the university which has a greater interest in its success and welfare? A board of trustees composed of certain members elected by the trustees themselves, others elected by the faculty, and still others by the alumni, would be a truly representative body. (If a state university and the trustees are appointed by the state, the election of trustees by the trustees themselves would probably not occur.) Alumni, faculty, trustees and president, all would participate in the administration of the university. In this way all of the constituent parts would come into closer relation with each other and if unity is strength in the republic it should be so in the university. Sections (3) and (4) of your circular seem to me very desirable.

I agree that the system of control current in American universities calls loudly for readjustment. The powers vested in the presidency should be more narrowly limited than at present, especially as regards appointment, salaries and the departmental distribution of funds. The authority of the officers of instruction should be augmented in matters directly or indirectly touching the conduct of the several departments. The trustees should be responsible to the whole university. (1) The type of "corporation" proposed might work; I am uncertain. I suspect that its most difficult occupation would be the equitable distribution of income from university properties. (2) It is absurd to declare that the president's "salary should not be larger, his position more dignified or his powers greater than those of the professor." The important point is, surely, that the authority be properly delegated, and the dignity and salary earned. (3), (4) and (5). I find myself in substantial agreement; though the prescriptions are, in part, Utopian.

The present system could no doubt be much improved. The great trouble seems to be that investigators do not give time or interest enough to such matters. They will always be too deeply buried in the laboratories and this renders the situation difficult to improve.

The plan you propose would certainly be vastly superior to the present plan. As to its details I am not competent to judge.

The form of organization outlined by you seems to me to be an ideal one and I would be prepared to endorse every paragraph as you present it.

I have read your tentative plan of university control to be reached as the result of gradual evolution with much interest. It seems to me perfectly feasible and I am certainly in hearty accord with its main purpose, viz., to do away with the despotism of the president and of the heads of departments. The present system of control in our universities is certainly not the best that could be devised and is unworthy of a democratic country like ours. Your plan has much in it that commends itself to me from my experiences as a university professor and I hope that you may succeed in bringing about some reform of the present system at least. Intelligent discussion of the subject can certainly do no harm and it may direct attention to the matter and thus ultimately do some good.

While I may not have very definite views on the points you raise, still a few of them have of course been considered by all academic men. (1) The body of trustees should be large enough to prevent perpetuation of whims and irregularities that may creep in in times of special pressure. Footnote 2 is a good safeguard. (2) As most of my own preparation was in a German university, I heartily endorse this view. It is not a promotion when an able and active professor is asked to assume the executive duties of a president. It frequently stifles the man and does not magnify the office. (3) These groups should not have enough autonomy to allow one group to pool its interests against those of another. It can be remedied easily by enlarging the relations you outline in (5). There is danger of lessening the community of interests with other departments when one or two groups grow in numbers and importance. Other groups may be forced to the wall. Footnotes 8 and 9 meet my hearty approval. An instructor should not feel that it is simply a matter of routine to await promotion, but rather that it lies largely with himself whether he advances.

In general, taking your plan for granted, and without going behind it at any point, I should say: It is too bureaucratic; it substitutes one mode of high organization for another. But I do not believe in organization at all; or rather, given the minimum with which an institution can exist, I should prefer to let the organizations within the institution grow at haphazard. My ideal, still in terms of your plan, would be: (1) A faculty with an annually changing chairman; (2) a board of trustees; (3) an annually changing faculty committee of say ten men, to meet with a similar trustee committee; and (4) paid permanent extra-faculty officials; registrar, treasurer, secretaries of faculty, whatever they may be called and as many as the size of the university may demand. Everything else in the way of predetermined or foreseen organization—directors, deans, school-units, appointing boards, etc.—I regard as cumber. And, publicity being presupposed, I should let every institution follow its own natural line of development. If I turn now to your proposal in detail, I should have the following criticisms; I can only state them dogmatically: (1) I think that the state universities are not comparable to the endowed universities; I think it will be a long time before they can possibly be universities; and I think that they are tending away from that ideal towards the development of vocational and professional schools. Your plan contemplates the perpetuation of the large universities, *i. e.*, of the present college-university mixture. I believe that college and university should be personally and spatially separate. I do not think that one can start with the corporation; and it is not necessary to do so, as we have boards already. I mistrust alumni, in anything like equal numbers with faculty; here, I suppose, everything depends on the age of the university, the character of its student body, etc.; I can only speak from experience. I also mistrust the "community," if that means the immediate surroundings of the university. (2) All right as an intermediate measure; but I believe in annual rotation, and I think it would suffice. (3) These are natural units, and need no organization. To make them formal would have its positive disadvantages (inbreeding of ideas, cliquism) and would also do injury to the smaller divisions, which would have to be affiliated to some stronger unit. Psychology, *e. g.*, would have to go to philosophy or education or biology. If a formal unit is required at all, I prefer a unit in which men of very varied interests are bound to meet together in behalf of the university. It would, I think, be a good thing for me to have to dine once a month with an architect, engineer, historian, agriculturalist, biologist, lawyer. These units, if necessary or advisable, might be determined by lot. (4) Far too bureaucratic. Let all business be wholly public, but let representation, appointment, etc., be settled in detail locally by the separate institutions. Do not try to measure "amount of work"; let the candidate understand the present duties of the chair, and then, if he is elected, give him a free hand. (5) Still too bureaucratic. Let every proposed measure that finds a specified number of seconders be voted on always by the whole faculty by postcard; if a meeting is wanted, let it be demanded of the permanent secretary by a specified proportion of the whole. If the mover is keen, he can print and distribute his arguments. As the first step in advance, I should accept your suggestion of a regular joint-committee of faculty and trustees. As the second step, I should abolish all salaries of deans and directors. I should put extra-faculty permanent clerks in training. Meanwhile, if a faculty-member has to be dean or director, I should excuse him in so far from university work, but should allow him only the professorial salary. I should aim throughout at the realization, by every member of the faculty in the widest sense, that he must be both responsible and loyal to the university, *i. e.*, to his fellow faculty-members and to the students. I should hope that in time the idea of the "university" might include the trustees; though it will, I fear, be long before the professor ceases to regard the trustee as his natural enemy, and the trustee to regard the professor as a fool to be kept harmless. I should hope, also, that in time the whole university, faculty and trustees, might be capable of combined action on definite educational lines; even if this took a generation, I should not mind. I dislike difference of title; and I should hope that in time there would be no difference, save of permanency of appointment. We should then have, perhaps, professors elect and professors designate, and that is all; perhaps we might even abolish titles altogether. I do not believe in specially high salaries within the university. A great deal of this is, under present conditions, utopian; I do not think that I could myself live up to my ideals; brutalities and jealousies warp one even against one's will. But I think that with some suffering and many relapses for a generation, the utopia might be approximated.

Your general summary of university evolution from comparatively small colleges to their present dimensions and complex interrelations I have seen with my own eyes. I think that every one who has helped in the evolution of the American university to the present stage expected a simpler organism than actually came from their efforts; and perhaps sometimes we feel hardly willing to accept our own creation. As you say, there was comparative order and simplicity in the smaller institution; but there is now complexity, and reversing the order of the creation described in Genesis, there is considerable chaos as a result of our creative efforts. But we are not through yet, and in some such plan of representative government as you have outlined, I believe a glorious youth and maturity are before the American university. To answer the questions in order: (1) This is practically the system I have lived under. (2) This seems to me an unnecessary complication. In No. 5 there would naturally be a chairman chosen for the group or groups meeting together. (3) This is entirely practicable and works well. (4) This is the kernel of the whole matter, and by contrast brings out the real difficulty in American universities. We are too much "boss ruled," and have too little of the true principles of self government; and self government is at the root of all permanency in a free commonwealth whether political or educational. The method you propose, in part, I have lived under and know that it is practicable. I have also lived under a system in which over-lords were appointed by a higher over-lord to rule over each province—in a word "boss rule"; and it destroys the fine spirit of a university as it does that of the state and the nation in political matters. I think that in no situation in life is leadership more desired and appreciated than in a university; but leaders, to be followed, must be chosen by, not imposed upon, a faculty group. (5) This is a logical sequence to (4).

LETTERS FROM THE UNIVERSITY OF CHICAGO

I feel very little sympathy for the type of organization which you recommend. I spent seven years in an institution which had a democratic organization on its faculty, and I am persuaded that that organization is defective in more ways than the organization at such an institution as Harvard or Chicago. It is defective first, because of the difficulty which always arises when one tries to convert a body of men to new and progressive policies. It is very much easier to get the ear of one intelligent administrator, and carry through a policy of reform, than it is to get the sympathy of a number of heads of departments. In the second place, I do not believe that heads of departments are as efficient when it comes to deciding general policies for an institution as some detached executive officer who can look beyond the interests of each of the departments. The experience of such institutions as Yale and Cornell seems to me to be conclusive against the democratic organization. They found exactly the same difficulty in Cornell and voluntarily voted away the authority which they at one time held. I am not optimistic, either, about the ability of academic men to organize their own government. I think that the specialist in science or literature prefers to have somebody develop the methods of scientific organization and relieve him of the necessity of considering these matters. In other words, an administrative officer equipped with methods of investigating his own problems seems to me to be a very proper solution of the difficulty in which we now find ourselves.

As regards your first proposition, I may say that it seems to me at least harmless. If it resulted in attaching to the university a larger group of serious-minded and intelligent persons than is at present the case, I should think it in so far useful. I am not clear that the chancellor, for whom you make provision, would be a particularly useful official, unless he were content to remain largely ornamental, as is often the case in the English universities. His usefulness in that case would be of a sort not likely to come into conflict with the policies adopted by those more directly responsible for the conduct of affairs. Your proposition under the second heading to elect a president from the members of the faculty and to give him no larger powers and no larger salary than is received by other members of the faculty strikes me as somewhat impracticable. I can not imagine any man whose intellectual capacities and attainments would justify his presence on a faculty of a first rate modern university, who would be willing to make the sacrifice of time and strength necessary to assume administrative control under such conditions. Possibly members of the department of education might find in such a function a professionally advantageous occupation, but for other members of the faculty it could only be a time-consuming and thankless job from which the abler men would unquestionably shrink, and presumably would succeed in avoiding. The idea that the faculty should have some voice in the selection of a president I heartily approve, but our own generation seems not to be in sight of such a distribution of administrative detail as would justify any able scholar in turning his attention to this phase of university work were he not rewarded by some increase in his salary or his powers. The application of your suggestion in point three meets my hearty approval. Experience has abundantly shown that we need a smaller unit of organization with very definitely specified responsibilities if we are to secure effective and intelligent participation by members of the faculty in university government. The fly in this particular ointment comes at the point where the interests of any particular group may run counter to those of some other similar group. You provide in your fourth paragraph that such a group shall have as complete autonomy as is consistent with the welfare of the university as a whole. This means that some one has got to decide whether the welfare of the university is or is not in any given case invaded by the action of one or another department. You will then have to fall back on a larger body, or on some administrative official who may prove to be an unjust judge. I do not regard this difficulty as insuperable, but I could relate instance after instance in which it has proved practically very serious. I approve also very heartily the spirit of your suggestion in paragraph four that nominations to professorships shall be subject to a competent advisory board. You supply a rather undue amount of machinery for this purpose, but some check of the kind represented by a competent board is certainly highly desirable. I also approve the suggestion whereby each unit should have control over the expenditure of its own funds. I feel that at the present time a large part of the most irritating difficulties which members of the university faculty encounter concerns the necessity they are under of making a purely personal appeal to the president and trustees instead of being able to distribute as they may think wise a specified portion of the university funds, and instead of being permitted to augment those funds as they may be able. Your final sentence in paragraph five is a gem. "There should be as much flexibility and as complete anarchy throughout the university as is consistent with unity and order." In other words, there should be a chaste and orderly disorder. This also I sympathize with, though the actuaries give me no reason to hope that I shall survive to see it in operation. In general I feel very strongly that the present situation has many very undesirable features attaching to it, of which not the least is that the president tends too largely to become a purely fiscal officer whose interests and outlook are almost wholly financial in character. No doubt this aspect of the great modern university must be cared for, but I think it is a great misfortune that the more purely educational and scientific interests can not be placed upon a more autonomous basis whereby for any given year at least, or indeed for any period of five years, the authorities in charge of a division of the work of the university may know to a nicety the minimum sum at their disposal, and may be permitted to expend it as it seems to them best. The subserviency to the president and trustees which the present system breeds is both morally and educationally wasteful in my judgment, and that it produces a destruction of esprit de corps and the higher forms of loyalty is too obvious to be debated.

In a general way your scheme of university organization seems to me to be an admirable one, although there are a number of difficulties which the plan has in my mind. In the first place, I think the plan of operation would work out very much better in an organization having a considerable degree of homogeneity than in a university having a very large number of academic and professional departments with little or nothing in common, and frequently with sharply conflicting interests. Might it not happen, for example, in a school of the latter sort, that the professional interests, which are usually rather rabid in their demands on account of their practical value, would completely outweigh those of pure science and academic work? It seems to me that we might expect exactly this to happen when the law, engineering and medical faculties are brought into contact with the pure science groups, and it is especially injurious to the interests of the academic and pure science groups that the applied schools have a larger number of faculty members than the academic and strictly scientific bodies. If all productive endowment were divided up so that each general group in the university would have its own funds, and was to all intents and purposes an independent school financially, the difficulty would not be so great, but if all the funds were contained in one general endowment I think there would be serious difficulties which would prove most injurious to the things most worth while in our university. This is the most serious phase. Secondly, with regard to the constitution of the corporation. It seems to me that the admission of any very considerable body of alumni and members of the community where there is sufficient homogeneity of interests might be all right. On the other hand, would there not be the danger of getting in those who gain their popularity from their fellows through athletic contests and social position, rather than through real worth or capacity to take part in the deliberations of the corporation? It might also lead to a situation in which the faculty would be compelled to take cognizance of temporary, erratic, social beliefs. Still, leaving out these difficulties which are not insurmountable, the plan of organization proposed under (1) is probably better than that in vogue in our institution at the present time. The various provisions provided for under (2) seem to me to be rather desirable, and need, I think, no comments. I am not sure, however, that your suggestion of an annual election of a director is a wise one, because the complexities which exist in an institution of this kind, I imagine that it would take the larger part of the year for a man to learn the task before him. A period of five or ten years might be highly desirable, and I would also suggest that some sort of provision be made for referendum and recall when the administrative officer is no longer satisfactory or when his policies become unbearable to the rest of the professorial body. I think opinion would differ very much with regard to number (3), especially with regard to the size of the group which you suggest as a psychological constant. In principle, however, these aspects of university organization seem to me to be admirably conceived of and very much in advance of the present arrangement. In (4) and (5) I think I have nothing to comment upon. I am in harmony with the principles expressed therein, with the single exception, under (4), that the division should have financial as well as educational autonomy, which would depend upon the type of financial organization adopted in the institution. I judge that your plan would be to have a series of separate endowments for the departments. I would like very much to see this sort of thing put into operation and see how it works out.

It must be clear to every one that in the small college of earlier days the president's ideas on college policy and the policy of his college were almost or quite identical. Furthermore, the college seems to be about as conservative an institution as we have in this democratic country. This early college president was usually conversant with practically all the subjects taught in his college. The number of subjects was limited and confined almost entirely to the classics in which the president had received his own training. Since that time the sciences and humanities have been differentiated into so many subjects that no college president pretends to know much about many of the fields of work covered in the college curriculum. It must be equally clear that in order to represent the interests of all these various departments the opinions of all must be considered. The field is certainly too broad and too specialized to enable any one man to govern all of them adequately and justly. If the faculties were incompetent that of itself would be justification for a continuation of the earlier policy, but that claim can not be upheld. Democratic government of a university would certainly make a place for utilization of the intelligence and sympathetic cooperation of the large number of men who are really interested in university administrative affairs. To speak of your propositions by number I wish to say: First, that responsibility placed upon a larger number of men is certainly desirable and your plan for securing it appeals to me. Secondly, the president certainly should be selected because of his "expert knowledge of education and university administration." I do not quite see how it would be possible to have a president and a chancellor both operating to the best advantage to the university without having their fields overlap considerably. For example, the public is quite as much interested in the educational aspects of the university as in its business aspects and in its connection with public affairs. Thirdly, the departmental unit seems best to me. Fourth, in a great many of the universities at the present time appointments to major positions are made only upon nominations which are the result of careful consideration by all the faculty of the department in question. It seems desirable that that plan should be made general. Fifth, I like the proposition of number five if we assume that the senate or the general faculty of the university has prepared a full and definitely stated constitution outlining the policies—administrative, financial and educational—of the university as a whole. This policy should be general but definite and should leave autonomy to the departments on all questions that are at all likely to concern departments only. But general policies should certainly be stated in a general constitution that would outline the functions of the university as a whole.

Your suggestion (1) seems to me a good one, in that it would restrict the powers of the board of trustees to those affairs of the university which are non-educational and at the same time dignify leadership in that very important department of university administration. I am not sure that I should like to see a university faculty, as a whole, take part in the election of the president, but it seems to me that the faculty should have influential representation by a committee composed of its most influential men, possibly elected by the faculty as a whole, on the appointing body. The division of the interior administration of a university into parts seems to me essential to economy, and I think that the association of a committee or member of the board of trustees with each of the partial faculties would tend to a better understanding between those interested in the educational and the other work of administration. The question of appointments and promotions seems to be a difficult one. Your plan seems to me well suited to insure good new appointments but I am not so sure about appointments which are also promotions. In either case it seems to me that the department concerned should be well represented by an elected committee, and the final appointive power should be vested in a number of men rather than a single one. I do not believe that any two men holding the same kind of position do the same amount of work, and think that the salary should be adjusted accordingly, possibly between limits specified for the particular office in question. Many good men are lost and others lose ambition when a salary schedule is rigid. I like the idea of a university senate working in coordination with the trustees, and the ideas expressed in your section (5) for bringing the trustees and faculty into closer touch with each other.

The plan you propose seems to me to be excellent for an institution that is given over largely to teaching. In smaller colleges the various members of the faculty see each other frequently and each keeps in touch with the work of the institution. Your plan, as I understand it, contemplates similar intimacy among groups in the larger organization. While I believe that your plan would work well and be a great improvement in an institution given over to teaching and in which the proper care of the students and of their problems was of first importance, it seems to me that a university that attempts to make research its highest aim, would have difficulty in carrying out your plan. At present, with the autocratic form of government which we have here, the research men complain bitterly of the amount of time required for committee work, faculty meetings, etc. Your plan would increase the demands on them in this respect. Since my main interest is in the teaching side and in research in education, I would like to see your plan tried, but I feel certain that the men interested in research in science will object to it for the reason stated.

(1) This paragraph seems to me good, though the plan referred to in the footnote of deriving income from fees from members of the corporation is bad. Either the income so derived would be small or else the financial burden on the trustees would be such as to encourage the selection of trustees on the basis of their financial rating. (2) The president should be elected by the faculty, but the office of president, like that of professor, should be a permanent one for the sake of continuity and stability of administrative policy and the precise localization of responsibility. The salary should be adequate to get the best available administrator regardless of salaries paid to other officers. Much more important than the president's salary is the control of the university budget, which should be taken out of the president's control and lodged with the faculties or senate. (3) Good. (4) This I approve, save that I think it unnecessary that the professors' salaries should be uniform. Footnote 8 seems to me especially sound and important. (5) This commends itself to me as good. In general, I

think the plan proposed or slight modification of it is both good and practicable.

In general, the proposed scheme for university control appeals to me as excellent. I particularly approve of the statement to the effect that the fundamental difficulty in the situation lies in the fact that the president is responsible only to the trustees, while the professor is responsible both to the trustees and to the president. We are having a little experience in connection with note 6, having two practically independent institutions for research, closely affiliated with the university, and so far it has been a very satisfactory arrangement, at least from the side of the independent institution. What the university thinks of it, I can not say.

Your tentative proposal regarding the organization of our larger universities seems to me to be a lead in the right direction in that it aims to curtail the autocratic power of the president and to place the whole organization on a more democratic basis. I am not so sure, however, that the proposed changes would work out in practise, for even in some of our most democratic institutions there exists a tendency towards centralization of control. As an example of a university controlled by a corporation composed of professors, alumni and interested members of the community, one might cite the Marine Biological Laboratory at Woods Hole, where the actual administration is largely in the hands of the director. Ordinary members of the corporation have little or no voice in directing the policies or business of the institution. Although an annual meeting of the corporation might seem to furnish an opportunity for the ordinary member to exercise his franchise, this is really not the case, as all matters, including election of officers, are settled before the meeting. Thus may our most democratic bodies revert to oligarchy. It must be admitted, however, that we have in the Marine Biological Laboratory a close approximation to the ideal university conditions. In my opinion one of the most serious objections to the present autocratic type of university president lies in the fact that he may be, and sometimes is, a man of little force, readily influenced by certain of the more dominant members of the faculty, who are able to mould his policies often to their own personal ends. Thus arises favoritism, financial and otherwise, toward departments, which happen to have at their head men often of low scholastic attainments but highly endowed with the qualities of political leadership or merely with a pleasing and persuasive personality. The department headed by a man or men of scholarly tendencies and little or no time or inclination to curry favor, may, and often does, fail to receive a fair amount of encouragement or support.

There is no question of the need of some reorganization. The fact of the establishment of research institutes independent of the universities shows, I think, that the universities have lost the confidence of those desiring to aid research; and investigation is the *sine qua non* of university existence. For this our organization appears to me to be at fault, the main trouble being that the universities are actually not in the control of their faculties. The plan you suggest would return that control and is, therefore, good. Your general plan strikes me as very similar, with some additions, to that of the Marine Biological Laboratory at Woods Hole. This has worked extremely well in that institution. While the criticism is sometimes made that scientific men and scholars can not be trusted to manage funds, the Marine Laboratory entirely disproves such a notion. No institution in the country has made so little accomplish so much as the Woods Hole laboratory. I am a little uncertain what the duties of the president would be under your plan. I am inclined to think that the only men who are really competent educators are the scholars, and I fear you will have difficulty in finding any scholar willing to assume the duties of a president unless he have some additional recompense either of salary or power or honor. Certainly the president should be elected by the faculty, or the trustees should elect from two or three men nominated by the faculty. The organization of departments into autonomous divisions is a good scheme. We have lately adopted unofficially something of this sort here in the form of an advisory committee of all the biological departments. It works very well. This committee recommends to the president on biological affairs of general interest. As regards the organization of a department, I believe it makes little difference whether there is a head chosen by the president or a chairman elected by the department. I have lived under both systems. Each is good with the right kind of men in the department and each is bad with the wrong kind. I should like to see the plan tried.

I thoroughly agree with your general principles, especially with your demand that each department should have as complete autonomy as possible, and that there should be as much flexibility and as complete anarchy throughout the university as is consistent with unity and order. But it seems to me that your specified list of desiderata is somewhat too detailed, considering the great diversity of American universities. In particular I think that different rules ought to be laid down for the college and the university proper. I also doubt whether your method of appointing professors is the best. I think it dangerous to give any body of professors, except those in the special department concerned, a deciding influence upon the appointment.

The plan suggested seems to me to be admirable. I wish to emphasize my belief in the desirability of those features of the plan suggested in paragraphs (1) and (2), and in that part of paragraph (4) which deals with the nomination for professorships. The present system of control is, at least in most institutions, highly unsatisfactory and moreover is not really effective.

Of course, if I went through your paper with a fine comb, I could probably find something to criticize, but reading it in a proper spirit I find that it grows on me, and that the oftener I read it the more anxious I become to see it put in force. One criticism that first suggests itself is that there is nothing hard and fast about the plan, but that you offer alternatives wherever possible. This elasticity, however, is one of its good points, for the new method of controlling the university, if there is to be a new method, can not be put in force all at once in a state of perfection, but will have to be more or less experimental. It has seemed to me with the growing power of the president there has been a distinct retrogression in some directions, and that the great American universities of to-day, with their thousands of students, their hundreds of professors, are in some respects behind the small freshwater colleges of a generation ago. The president in many cases seems to look upon the university as his own property to be exploited for his own aggrandizement. He wants to be the "whole thing," and selects his professors, not on account of their fitness or researchability, but for personal reasons, and because they will toady to him. The independent man is made to feel that he is not wanted, and although his tenure of office is theoretically for life, things are made so uncomfortable that he is glad to leave. It has seemed to me that some of the presidents do not want men on the faculty who are bigger than they are, and although here and there a university may become great through having a truly great president the system is bad and should be eliminated.

I have read your article "University Control." It is most timely. I doubt if I can add anything of value to it. The trouble with the university president is often that he has to spread over too much ground and comes to rely upon the busybody who has the president's ear and a bag-full of rumors for his "information" upon which to base promotions. Also, if he takes his job seriously he will periodically "butt in" to the doings of a department of which he has only the most superficial knowledge. The university president should adopt the principle of relying on the professor and according him full liberty in his department. If suggestions are in order, I might offer the following plan of making appointments and promotions. The department committee to nominate first appointments to assistantships and other low-grade positions. The division (department group) committee to nominate for promotions or first appointments to instructorships. The body of full professors of any faculty to nominate to professorships in that faculty. Professors in all faculties to nominate the president. All elections to be by the trustees or corporation. The president to be elected for a limited term, and subject to "recall" by the faculty. The president to confer with professors, represent them before the trustees, and the university as a whole before the public. The executive agent of the trustees (comptroller), the president, and a prominent alumnus (elected by vote of the alumni or their representatives) to constitute a "board of estimate." Such a committee would unite the needs of scholarship, the good-will of the community and the limitations of the treasury and arrange the delicate adjustment between departmental needs and university income.

I am heartily in favor of some such plan of university administration as you propose. At present in some institutions control rests in the hands of a small group of trustees who happen to have the leisure, or the money, or the energy to take a leading part, but who are not necessarily qualified to understand the real problems of the American university. The trustees appoint the president, the president appoints the deans, the deans recommend departmental appropriations and promotions, and so a personal tinge is given to all the official relations of the regular faculty members. The present situation is purely fortuitous. Until the natural university groups are given complete autonomy, genuine university development and continuity must remain largely a matter of accident. In your plan as stated the principles outlined in sections (3) and (4) seem to me essential. Precise details must naturally be left for experiment.

Upon the whole your plan is quite in accord with my own views, and I believe that there is already a tendency among our universities toward its inauguration in part. I doubt the expediency of the chancellorship, nor do I think such a corporation as you suggest is at all practicable for the state universities, though possibly some plan whereby the elected or appointed state regents might be limited to the control of funds and to an indirect or direct veto of all matters not strictly academic might be feasible. Especially do I think that the presidency should be an elective office of the faculties. At present the highest honors and emoluments are given, not for scholarship and pedagogical excellence, but for executive and administrative ability.

I am in hearty sympathy with the proposed plan for university control. It is quite preposterous that in a republican form of government our institutions of learning should have what is practically an absolute despotism—while the universities of Europe are the most democratic in their form of administration. I doubt, however, if it be possible—without a disastrous revolution—to change the present status.

I have been president and professor in a state university, and in denominational colleges, and have added to this now my fifteen years' experience here. This simply means that I have looked at the problem of "control" from almost every angle. My conviction is that every group connected with a university should do what it is best fitted to do. Theoretically, the trustees are fitted to conserve and increase endowments, and no more. They should have nothing to do with determining educational policies or with selecting instructors. Theoretically, the faculty are fitted to determine educational policies, to select instructors and to distribute the available funds. As I understand it, these are the views you have worked out in the details of your scheme, and so it has my general sympathy. But my long experience with faculties has led to the belief that they are made up, for the most part, of very impractical men. They seem to me to be childlike in their selfishness and their idealism. I believe that this is largely due to the fact that they have been kept in childish bondage, and this simply means that they will have to be entrusted with large administration gradually. I certainly disapprove of the autocracy of the American university president, since I have ceased to be one. No developed institution needs any such dictator. It is not right for any man to hold such a relation to his intellectual peers. The details of your various propositions may be open to discussion, but their general bearing seems to me to be sound.

SCIENTIFIC BOOKS

Outlines of Applied Optics. By P. G. Nutting, Associate Physicist, Bureau of Standards, Washington, D. C. P. Blakiston's Son & Co. 1912. Pp. 234.

A generation ago text-books on physics, or special sections of physics, came for the most part from those who were connected with the higher educational institutions of the country. They were usually written by men who were teachers besides being physicists, and who instinctively assumed that the reader demanded a consistent presentation of mutual relations rather than of results.

With the development of large and well-equipped laboratories, some of which are wholly independent of educational aims or limitations, a new range of scientific literature is becoming developed, in which specialization of function is not limited to the author, but assumed equally for the reader. The non-technical reader is attracted by a title, and is assured by an introductory glance that the book contains much of value. He is not disappointed, but is perhaps temporarily disturbed by the necessity to shift his customary view-point.

The author of the present volume announces as his keynote the question of securing the best possible results in optical work. He calls attention to the fact that applied optics is practically untaught in any university. This statement is perhaps a little sweeping, but it is applicable to many of the institutions that in America are called universities. He says frankly in his preface, "the book has been prepared for the worker in applied optics rather than the student; for the men in the field designing instruments, measuring color, examining eyes, identifying illuminants, etc., who may find a suggestion of how to obtain better results or ready information on nearly related subjects."

No one would be apt to open a book on optics who has not already some knowledge of the subject, such knowledge as would cause him to recognize the formulas most commonly in use, besides recognizing the application of principles that are thoroughly established. A well chosen summary of some of these principles occupies much of the introductory chapter, including the formulation of laws connected with names of such investigators as Lambert, Bouguer, Fresnel, Kirchhoff, Stefan, Planck and others. Discarding some obvious typographical errors, and the use of a few words which need explanatory introduction for most readers, the chapter is welcome and interesting.

The second chapter is on the theory of image formation, a subject which bristles with difficulties for the student who aspires to master the various aberrations and the means to be applied for their elimination. The satisfactory presentation of such a subject requires much pedagogical skill, apart from knowledge of the mathematics involved. Pedagogically the author has not always kept in mind some of the principles which every successful teacher must habitually and almost automatically apply, if he wishes to assure himself that his auditors or readers are acquiring power rather than accepting underived formulas on trust. Technical terms are used without adequate definition, and various equations are set forth without deduction. Assuming that the intelligent reader has already studied the subject in detail elsewhere, the chapter constitutes a condensed summary; but to assure himself that he understands everything while reading, he will need to be somewhat industrious and patient. This may be said with full appreciation of the excellent list of references that is added at the close of every chapter. But the non-technical reader, if he becomes impatient because the demands of the student are not fulfilled, becomes reassured when he looks back into the preface; for he has forgotten that "the book has been prepared for the worker in applied optics rather than the student."

The next chapter is on the design and testing of optical systems. This subject likewise is mathematical, and the treatment is open to some pedagogical criticism; but the amount of information, non-mathematical in form, is increasing; and the individuality of the author as a careful and resourceful investigator is becoming more clearly manifest. Prior to the publication of this book he had become well known through his published work in several branches of optics; and for development in his chosen field it would be hard to find a better place than the Bureau of Standards.

From this point on, the successive chapters contain less material requiring skill in the art of presentation, but much that reveals the author's rich experience in the optical laboratory. He is at home in the discussion of optical instruments and the conditions under which they may be used to best advantage, in the methods of measuring refraction, and in the intricacies of physiological optics. In the treatment of colorimetry, illumination, photometry and spectrophotometry, radiometry and spectroradiometry, polarimetric analysis, plate grain and sensitometry, and interferometry, he has evidently worked with great skill and ardor, enjoying the work thoroughly. He has gleaned information from all possible sources, and has recorded in small compass what might well have been greatly expanded. The present volume is indeed apparently tentative. This is indicated in the preface, where the enterprise is referred to as an entering wedge, since the full treatment of applied optics "could be adequately treated only in a number of volumes by a dozen specialists." It is to be hoped that these volumes will appear in due time, but that upon them better editorial care may be applied than is manifested in this initial volume.

W. LeC. Stevens

Lexington, Va., July 10, 1912

Distribution and Origin of Life in America. By Robert Francis Scharff. New York, The Macmillan Company. 1912. Pp. xvi + 497, 21 maps.

Students of zoogeography the world over will welcome this book, for the author's masterful treatment of the European fauna[1] leads one to expect that he will bring to it the same wealth of ideas, sound knowledge and good judgment that characterize his previous work. In the opinion of the reviewer this expectation is fulfilled. The data are presented about as exhaustively as is possible in a work of this size, the opinions of different students are summarized in an unbiased way, the generalizations and data are carefully weighed, and the author's conclusions are clearly expressed.

Very little but good can be said of the general method of attack. Dr. Scharff fully realizes that problems of origin and dispersal can not be approached from the standpoint of zoogeographical regions, and no space is given to this subject. He analyzes separately the faunas of different parts of North, Central and South America, and of the Antilles, Bermudas, Galapagos and other American islands, and endeavors to discover the sources and migration routes of the different elements. He goes to some length to show the very small rôle which he believes accidental dispersal plays in the populating of distant lands—a method that has been clearly overestimated since the classic works of Darwin and Wallace—and expresses the conviction that the facts of North American zoogeography can best be interpreted by postulating various land bridges. When such land bridges are apparently called for, the author endeavors to gather evidence for them from botany, geology and paleontology.

Dr. Scharff argues for the existence in pre-Glacial or Glacial times of a North Atlantic land bridge, connecting Scotland, Iceland, Greenland, and Labrador, and a North Pacific

[1] "The History of the European Fauna."

bridge across Behring Strait. Unlike many students, however, he does not think that these are sufficient. He contends that there must have been an early Tertiary trans-Atlantic bridge from southern Europe to a hypothetical "western land" lying just west of the present American continents. This land bridge, according to Dr. Scharff, included the Antilles and parts of Central America, and was, by means of the "western land," first connected with both North and South America, then separated from North America, and subsequently reunited with North America and separated from southern South America. By such an hypothesis one can explain the European elements in southwestern North America and the Chilean region.

The "western land" was, Dr. Scharff believes, part of a great arc "which stretched mainly northward, communicating from time to time with Central America and the Antilles, and also with Mexico and western California, and then eventually bending across to eastern Asia in a great loop and thus joining New Guinea, Australia and New Zealand." This bridge is made to account, among other things, for the evidently continental fauna of the Galapagos Islands, the relationships between the living and extinct faunas of western North America and southern South America, and for the Asiatic elements in these faunas.

As has been intimated, Dr. Scharff believes in a former union of the Antilles with each other and with the trans-Atlantic land bridge and the "western land." He also thinks that the Bermudas and the end of the Florida peninsula (then an island) were also connected with this land mass. He further postulates a direct connection between Chile and New Zealand, but not by way of an Antarctic continent, and is willing to grant slender bridges between southern South America and South Africa and Madagascar. Although he does not dwell upon these southern bridges. he suggests that incentives to migration may have been found in changes in climate due to changes in the direction of ocean currents, so that Simroth's pendulation theory need not be relied upon.

The author's treatment of the Ice Age in North America will undoubtedly come in for a large share of criticism, for his views are quite different from those now almost universally accepted in this country. Very briefly, it may be said that he denies the existence of continental ice-sheets in the Pleistocene, although admitting that this was an age of extensive glaciation, and believes that the climate at that time was temperate and even warmer than at present. The large bodies of water forming the Pleistocene great lakes he attributes to a marine invasion. He does not believe that there was a general southward migration of northern forms in the Pleistocene, or that the southeastern states served as "biotic preserves" during the Ice Age, but thinks that the fauna in the drift area was in part destroyed and in part persisted in favorable localities. He emphatically denies that the evidence is sufficient to warrant the theory that zones of northern animals and plants were spread out beyond the margin of the drift area in a manner comparable to the present distribution in the far north.

The author himself scarcely ventures the hope that his views on the physical conditions during the Ice Age will be readily accepted. A growing number of zoogeographers in this country will, however, be quite willing to agree with him that current geological opinions are permitted to dominate biological thought to a far greater extent than the facts of distribution warrant. We should have more evidence of Pleistocene distribution and not try to erect elaborate theories principally upon geological evidence. It may be pointed out that, granting the ice-sheets, there is still no reason to believe that the margins of these were not covered for miles back with soil and vegetation, as Russel found to be true of the Malaspina glacier, in which case no zonal arrangement would prevail comparable to conditions in the Arctic regions at the present time.

A conviction expressed by Dr. Scharff that will have adherents is that southwestern North America is and has been in the past a very important center of dispersal, as some previous writers have contended. He believes that many of the forms that now have their center of dispersal in the southeast originally came from the southwest, either directly or possibly by way of the West Indies, and that changes in climate since the early Tertiary have extinguished the primitive forms in the southwest.

It has been possible in this review only to touch upon a few of the main points in the book, but enough has been said to show that many of Dr. Scharff's conclusions will not meet with general acceptance. However, even if they should be entirely overthrown, the general usefulness of the book will not, in the opinion of the reviewer, be impaired, for the summary of data and generalizations can only be of the greatest use and a source of inspiration to students of the American fauna.

Alexander G. Ruthven

RECENT ANTARCTIC WORK

National Antarctic Expedition, 1901–1904. Natural History, Vol. VI., Zoology and Botany. London, British Museum. 1912. 4to. Pp. xvi + 81, 8 plates.

With the publication of this volume, the series of reports of this expedition relating to the natural history is brought to a close. The special reports included in it are "On a Collection of Young Holothurioids," by Professor E. W. Macbride; on the Polychæta, by Professor Dr. E. Ehlers, and on the freshwater algæ, by Dr. F. E. Fritsch, these being the only freshwater organisms obtained by the expedition.

The series comprises altogether some fifty memoirs descriptive of the fauna and flora of the Antarctic region. This area, like other cold seas, teems with species, of which 227 new forms have been described in these volumes. Of some Amphipod Crustacea 10,000 to 20,000 were occasionally taken at a single haul and in the collection one species of Schizopod is represented by nearly 10,000 specimens. The great kelp (*Lessonia*) has a frond as much as 24 feet long, but the mosses show signs of degeneration. No evidence in favor of the theory of "bipolarity" has been gathered from the collection. Twenty-three new genera of animals, and 201 new species were obtained, and 26 new species of plants. The collection of young echinoderms includes free-swimming larvæ of three out of four groups of echinoderms, which is of interest in view of the opinion, which had been expressed, that all species of the polar seas would be found to have development of the shortened type without free larvæ.

The freshwater algæ are exceptionally numerous in species, 91 in all, belonging to 35 genera, of which 25 species are Diatoms. Huge sheets of *Phormidium* and occasionally of *Lyngbya* flourish in the ice and during the milder portion of the year in the waters of the ponds and lakes. These sheets serve as a substratum for a rich growth of other forms and are probably the breeding places for the bulk of the algal flora. The scarcity of green algæ is notable, while Diatoms are rather scarce, but desmids are relatively abundant. *Microcystis* sometimes colored the ice of a dull brick red. The conclusion is reached that reproduction in the bulk of the Antarctic algæ is a very slow process and possibly several seasons elapse before a new generation reaches maturity.

The plates of this volume attain the same high degree of excellence noticeable in the previous issues of the series, and a convenient index to the whole set is included both for authors and subjects.

Expédition Antarctique Française, 1903–1905, Commandée par le docteur Jean Charcot. Hydrographie-Physique du Globe, par A. Matha et J. J. Rey. Paris, Bureau des Longitudes. 1911. 4to. Pp. vi + 615, 9 plates, with figures in the text.

The expedition of Dr. Charcot on the schooner *Francais* was due to the enthusiasm of its leader and the generosity of private individuals aided by the efforts of the Parisian journal *Le Matin;* through which after a hard struggle something less than $100,000 was obtained, a small three-masted schooner built, and outfitted for two years. Instruments and books were lent, the members of the party served freely or for a nominal wage, and the official Bureau des Longitudes took the expedition under its motherly wing and has now published the volume of which the title is above cited.

This expedition was scientific in its aims and pole hunting formed no part of its program. The staff comprised five members beside the leader, with a crew of fourteen; all provinces of France were represented.

The plan of the leader was, in brief, to take up the work inaugurated by the *Belgica* expedition and extend it by explorations of the southwest part of Graham Land, investigating in all branches of science as well as geography, so far as their personnel and equipment would permit.

This program was carried out in its main features. The present volume includes an introduction in which a brief résumé of previous researches in the same region is given, after which the hydrography, tides, chronometric record, pendulum observations and the density and salinity of the seawater, are discussed by Lieutenant Matha, atmospheric electricity, meteorology and terrestrial magnetism by Lieutenant Rey. The work is carefully printed and the charts are of the quality one expects from the bureau which issues the volume.

Wm. H. Dall

SPECIAL ARTICLES

A CASE OF SEX-LINKED INHERITANCE IN THE DOMESTIC PIGEON[1]

In breeding work with tumbler pigeons begun at the Rhode Island Agricultural Experiment Station some years ago a careful study was made of the manner of inheritance of certain of the commoner colors of these birds, especially black, dun, red, yellow, blue and silver. This work was referred to in the Twenty-first Annual Report of the Station, 1908, p. 301, and a full report of the results, it is expected, will be published during the present year. These experiments made clear the fact that dun, yellow and silver are dilute conditions of black, red and blue, respectively. Indeed, this might have been surmised from their appearance, but the fact was substantiated by their behavior in the breeding tests. As has been found in other animals, notably in rabbits and mice, the dilute condition depends upon a single factor, or more strictly the absence of a factor, which produces the effect upon whatever color it chances to be associated with. In other words, "intense" is dominant to "dilute," that is, if the factor for the intense condition is present, the color of the bird takes that appearance. This relationship, in the case of blue and silver, has been pointed out by Bonhote and Smalley (p. 603).[2]

Although the earlier experiments showed the general relationships of these characters, it was only by the results of certain experiments of the past year that the interesting relationship of the intense and dilute condition to sex has come to light. No secondary sex characters (in the ordinary sense) exist in pigeons, and as a consequence there is no way of determining the sex of the birds until they are old enough to reveal it by their behavior. In the case of certain crosses made last year, in which the male parent was a dilute (yellow or dun) and the female a black baldhead,[3] both black and dun offspring were produced, and it became evident this spring that all the blacks were males, while all the duns were females. The following examples will serve to illustrate.

Case I.

Parents:	♂ 540 B, dun
	♀ 647 A, black baldhead.
Offspring:	790 A, black, ♂
	790 B, black, ♂
	847 A, dun, ♀
	893 A, black, ♂
	893 B, dun, ♀
	954 A, dun, ♀

[1] Contributions from the Laboratory of Experimental Breeding, Wisconsin Agricultural Experiment Station, No. 1.

[2] Bonhote and Smalley, "On Color and Color-pattern Inheritance in Pigeons," *Proc. Zool. Soc.*, London, 1911, pp. 601–619, Pls. XXIII.–XXVI.

[3] In this discussion pattern is disregarded, since it is due to independent factors with which we are not at present concerned.

Case II.

Parents: ♂ 473 A, yellow
♀ 650 A, black baldhead

Offspring:
799 A, dun, ♀
799 B, dun, ♀
841 A, black, ♂
890 A, dun, ♀
890 B, dun, ♀
938 B, dun, ♀
980 A, dun, ♀

A search of the records for other cases furnishes abundant evidence to indicate that the phenomenon is general, and under certain conditions holds for the intense and dilute factors, whatever the color concerned. The requisite conditions appeared to be the mating of a dilute male to a female showing the intense condition. Further investigation showed that this is a typical case of sex-linked inheritance in that in stock bred pure for the character in question one sex is always heterozygous. In this case it is the female which is heterozygous, the character involved being the intense condition of pigmentation. In respect to the sex concerned this character corresponds to barring in the fowl and to color in *Abraxas*, and differs from color blindness in man and the numerous sex-linked characters which Morgan has found in *Drosophila*. These results have furnished a satisfactory explanation of certain formerly disquieting records in which birds bred "pure" and supposedly homozygous for the intense condition have produced some dilute offspring when bred with heterozygous or with dilute mates. It is now found that in all such cases noted the birds in question were females and, furthermore, that all the dilute offspring, so far as at present observed, were likewise females. A thorough analysis of the subject is now being made and the detailed results will be published in the near future.

The results mentioned above may be satisfactorily represented by either of the accepted modes of symbolism which have been employed in similar cases. Without committing ourselves to any theory, we may here follow the usage of Spillman and of Pearl in explaining the inheritance of barring in poultry. In these formulæ F represents femaleness, and the female is always heterozygous (Ff) with respect to this factor. Males, on the other hand, are assumed to lack this factor entirely, and are accordingly homozygous ff. We may then let B represent the factor for black, in the absence of which (b) the bird is red. These colors are modified, however, by the presence or absence of I, the factor for the intense condition. In the absence of I (represented by i) black becomes dun, and red becomes yellow. It is now necessary to make only the further assumption that F and I can not occur together in the same gamete. The cases given may then be represented as follows:

Case I.

Parents: dun ♂ $= fBi \cdot fBi$
black ♀ $= fBI \cdot FBi$

Gametes: ♂, all fBi
♀, fBI and FBi

Combinations: $fBi \cdot fBI$ = black ♂♂
$fBi \cdot FBi$ = dun ♀♀

Case II.

Parents: yellow ♂ $= fbi \cdot fbi$
black ♀ $= fBI \cdot FBi$

Gametes: ♂, all fbi
♀, fBI and FBi

Combinations: $fbi \cdot fBI$ = black ♂♂
$fbi \cdot FBi$ = dun ♀♀

It will be seen that these expectations accord with the results obtained.

It has been mentioned that this explanation accounted also for certain unexpected results from birds which were at the time supposedly homozygous. A single example will suffice.

Parents: ♂ 681 B, black
♀ 701 A, red

Offspring:
846 B, yellow, ♀
892 A, red, ♂
892 B, dun, ♀
944 A, black, ♂
944 B, black ♂

It was known from his ancestry that 681 B was heterozygous, both with respect to B and I. But had 701 A been homozygous for I, as supposed, all the offspring should have shown the intense condition of pigmentation, namely, black and red. The unexpected appearance of the dun and yellow birds is satisfactorily accounted for on the assumption that she was heterozygous, as follows:

Parents:	black ♂ = $fBI \cdot fbi$
	red ♀ = $fbI \cdot Fbi$
Gametes:	♂, fBI, fBi, fbI and fbi
	♀, fbI and Fbi
Combinations:	$fBI \cdot fbI$ = black ♂
	$fBI \cdot Fbi$ = black ♀
	$fBi \cdot fbI$ = black ♂
	$fBi \cdot Fbi$ = dun ♀
	$fbI \cdot fbI$ = red ♂
	$fbI \cdot Fbi$ = red ♀
	$fbi \cdot fbI$ = red ♂
	$fbi \cdot Fbi$ = yellow ♀

That is, 2 black males: 1 black female: 2 red males: 1 red female: 1 dun female: 1 yellow female.

While the number of offspring is too small on which to base any conclusion as to proportions, it will be noted that all so far obtained fall in line with the expectations as to color and sex.

The foregoing may provide an explanation of the interesting observations of R. M. Strong on the sex of ring-doves,[4] and those of Bonhote and Smalley (*loc. cit.*, p. 617, footnote), as well as possibly those of Whitman reported by Riddle.[5]

[P. S., July 22, 1912. Since the foregoing note went to press there has appeared in the June, 1912, number of the *Journal of Genetics* (Vol. 2, No. 2, p. 131) a paper by Mr. R. Staples-Browne, in which the relation of blue and silver to sex is amply demonstrated.]

Leon J. Cole

THE INTERTUBERCULAR OR BICIPITAL FORAMEN OF THE HUMERUS OF THE GUINEA-PIG

The upper extremity of the humerus of the guinea-pig often has an unusual, probably an unique, structure. A broad and thick bridge connects the large and small tubercles and converts the intertubercular sulcus into a foramen through which passes the tendon of origin of the *m. biceps*. At the last meeting of the Association of Anatomists, I reported that among twenty skeletons studied, four humeri from three individuals, two males and one female, were found which had this peculiar structure. Recently, through the kindness of Professor Castle and Dr. Detlefsen, of the Bussey Institution, I have been allowed to study their large collection of guinea-pig skeletons and was surprised to find the remarkable prevalence of the intertubercular foramen. Out of a total of 125 humeri, 17, 13.6 per cent., have complete foramina. Besides these 23 others, 18.4 per cent., have nearly complete bridges over the intertubercular sulci. In six instances, this bridge is formed by a small supernumerary bone which is wedged in between the great and small tubercles; in the others, by small acute processes which project toward each other from the adjacent sides of the tubercles. One or two similar but smaller processes occur upon 50 humeri, 40 per cent. of the total number, the remaining 35 bones, 28 per cent., having no indication of the foramen.

All of the skeletons used are of adult or subadult animals, but as the growth of the guinea-pig continues long after sexual maturity, possibly throughout life, it is probable that had the animals been older, an even larger proportion of complete foramina would have been present.

In all cases, the foramen has the same character. The upper edge of the bridge is convex, its lower edge concave. The canal-like foramen is narrow above, but rapidly widens below and terminates in an oblique, flaring and funnel-shaped mouth which is surrounded by a rough, slightly elevated, lip.

It seems impossible to correlate the occurrence of the intertubercular foramina with sex, age or muscular development. Foramina do not occur in immature animals, but, on the other hand, they are absent in certain very old animals (three or four years old) and furthermore they are occasionally present upon one side only.

Leonard W. Williams
Harvard Medical School

[4] Science, N. S., Vol. 33, p. 266, 1911.

[5] Science, N. S., Vol. 35, p. 462, 1912.

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A NATIONAL UNIVERSITY, A NATIONAL ASSET; AN INSTRUMENTALITY FOR ADVANCED RESEARCH[1]

GUIDING PRINCIPLE

At the outset the guiding principle may be laid down that at Washington there is no necessity for a university of a type which exists elsewhere, no need of an additional university like the great endowed and state institutions of the country. One who advocates a national university at Washington with the idea that it shall be a larger Harvard, Yale, Columbia, Cornell or Chicago, a larger Michigan, Illinois, Wisconsin, Minnesota or California, will fail in his advocacy, because he can not give to congress a sufficient reason for the expenditure of public funds for another university of a kind of which there is a sufficient number. Not only would such an advocate be met by the above fact, but by the fact that in Germany, where universities are most highly developed, they are state, not national, institutions.

If then it is not desirable to establish a bigger Harvard at Washington, what is the aim of those who are advocating a national university? It is to make available for the advancement of knowledge the unparalleled facilities of Washington to graduate students.

At Washington are the Congressional Library, the National Museum, the Smithsonian Institution, the Geological Survey, the Bureau of Mines, the Naval Observatory, the Public Health and Marine Hospital Service, the Army and Medical Mu-

[1] Prepared for the meeting of the National Education Association, held in Chicago, July 6–12, 1912.

seum, the Office of Public Buildings and Grounds, the Board of Ordnance and Fortifications, the Bureau of Navigation, the Bureau of Education, the Weather Bureau, the Bureau of Animal Husbandry, the Bureau of Plant Industry, the Bureau of Chemistry, the Bureau of Soils, the Bureau of Entomology, the Bureau of Biological Survey, the Bureau of Corporations, the Bureau of Manufactures, the Bureau of Labor, the Bureau of the Census, the Coast and Geodetic Survey, the Bureau of Standards, the Bureau of Statistics, the Bureau of Fisheries, the Bureau of Immigration and Naturalization. In these and other bureaus and divisions are available a vastly wider variety of material for scientific research and greater collection of books and manuscripts than elsewhere exist. To enumerate in detail the facilities and materials available for work in each of the domains of knowledge would require more space than is allowed for this entire paper. Also, such a statement is rendered unnecessary because of the admirable report[2] regarding the matter by President Arthur T. Hadley, but to serve as illustrations some of the facilities for a few of the lines of knowledge are mentioned.

For the modern humanities—political science, political economy and sociology, there is a wealth of material in nearly every department. The Department of Labor, the Interstate Commerce Commission, the Census Bureau, the Bureau of Statistics, the Bureau of Pensions, the Bureau of Immigration and Naturalization and the Bureau of Corporations, are all applied divisions of political economy and political science. Nowhere else in the country is there such a mass of first-hand information regarding many of the most pressing problems for these subjects. Also the various government activities of Washington, comprising congress, the executive offices, the judiciary, and their numerous divisions and branches give illustration of practical political science on the largest scale. At Washington not only may the student of political science have the material of the subject, but also he may appreciate with what labor and difficulty results are achieved in practise.

For history, and especially the history of America, at the Congressional Library is a vast amount of material, indeed practically everything which is in printed form; not only so, but in the library is a vast collection of documents. In the State Department, the War and Navy Departments, etc., are the archives of the government since its foundation, all but a small part of which are available for the student of history.

For anthropology, the National Museum and the Bureau of Ethnology have collections and materials of the first order of importance; indeed no other collection of the country can approach them, with the exception of the American Museum of Natural History in New York.

For physics, astronomy and mathematics, there is a great mass of material in the National Observatory, in the Bureaus of the War and Navy Departments, in the Coast Survey, the Bureau of Standards, the Weather Bureau, the Patent Office and other departments.

In chemistry, there are laboratories in almost every department and bureau which deals with materials, both organic and inorganic.

For geology and its related subjects, geography, physiography and paleontology, at the Geological Survey and the National Museum is found one of the world's largest collections.

[2] "Facilities for Study and Research in the Offices of the United States Government at Washington," by Arthur Twining Hadley, Bulletin 398, U. S. Bureau of Education.

For biology, there are available the National Herbarium, the Biological Survey, the Commission of Fish and Fisheries, the botanical division of the Department of Agriculture, the National Museum and other departments.

Passing now to applied science: Almost every phase of advanced engineering work is illustrated by some division of the government. The material which would be especially available is that found in the War and Navy Departments, the Bureau of Mines, the Coast and Geodetic Survey, the Division of Architecture, the Hydrographic Office and the Land Office.

For agriculture, practically the whole department, except administration, is devoted either to the advancement of the science or to the dissemination of practical information. This great department has an appropriation for 1911 of more than $20,000,000, the larger part of which went for scientific and extension work. An enumeration of the divisions of the Department of Agriculture shows how wide is the scope of this work—the bureaus of Animal Husbandry, Plant Industry, Weather, Forest Service, Chemistry, Soils, Entomology and Biology.

While the Department of Agriculture has by far the largest appropriation for scientific work, the appropriations for scientific purposes in other divisions vary for each from more than $100,000 to more than $1,000,000.

While it would not be easy to give an accurate statement regarding the amount of money which is available in the various departments at Washington for investigation and for the tools of investigation—apparatus and books—it is safe to say that the total amounts to many millions of dollars per annum; or put in another way more than ten times as much as any single university or institution in the country for this purpose.

The vast collections of books in the Congressional Library and the large special libraries in the various departments, especially those of the Geological Survey, the Surgeon-General's Office, and the State Department, cover a greater number of fields of human knowledge with an approach to completeness than exists elsewhere in this country. These libraries are admirably administered. Expert assistants are available, so that the material on any given subject is readily secured. Not only so, but special privileges are granted in the reading rooms and in the stacks to qualified students. The facilities in these respects are incomparably beyond those of any library in other countries. It is safe to say that the collections of books in the government libraries at Washington could have an efficiency ten times as great as they now have at a small additional cost.

Manning the scientific bureaus and divisions are a scientific staff many times larger than in the largest university in the country. It is this amazing wealth of men and material at Washington that should be available for the production of scholars and investigators along many lines.

THE DEMAND FOR IMMEDIATE RESULTS

At the present time, unfortunately, the demands for immediate results by the government compel the great staff to give by far the larger part of their energy to special problems with reference to practical ends. The rich materials from the larger point of view of the advancement of science are in large measure neglected.

LARGE SCIENTIFIC RESULTS OBTAINABLE

If in each of the bureaus and departments mentioned there were advanced students working on the materials there existing, not with reference to the solving of particular problems which engage almost exclusively the attention of the existing staff, but with reference to the advancement of science, there can be no doubt that results of untold value would be obtained. It is believed that the utilization of this material in any bureau or department by a limited number of students need not interfere with the efficiency of the department in reaching the immediate results demanded by the government. Not only so, but it is believed that a group of advanced students, which in any department would not be very numerous, but which in Washington as a whole would aggregate a large number, could be made the means of greatly improving the work of the scientific staff of the various bureaus.

In making the statement that the bureaus at Washington yield relatively little in the way of broad scientific results, it is realized that there have been and still are some exceptions. When the United States Geological Survey was originated there were drawn to Washington the most brilliant group of geologists in the country. This survey for a number of years was the center of the world for the advancement of the science of geology; but in recent years, while the organization is vastly larger, having appropriations of millions where it had in the early days appropriations of hundreds of thousands, it is almost exclusively a department of practical geology. It is not contributing in any large way to the advancement of science.

That contributions of the Naval Observatory to science have not been large has been known for many years. In 1898 a report was made by a committee of astronomers showing that the practical duties of the Naval Observatory could be easily performed by a very small establishment. In this report it was pointed out that a national observatory is justified because astronomical observations and research might there be made which can not be accomplished at private and university observatories. The great new observatory building at Washington is splendidly equipped to carry on researches of the highest character; yet at the present time the advancement of the science of astronomy in this country is through Harvard, Yerkes, Lick, Mt. Wilson and other university and private observatories. The astronomers all agree regarding the first step necessary to remedy this situation, as does also the president of the United States and the committee on naval affairs. There should be appointed a civilian astronomer of the highest rank as director of the observatory. If this were done and the large facilities were made available to advanced students, this institution might take first place among the observatories of the world.

At the present time the advancement of science in its broader aspects is contributed to by only a few of the scientific bureaus at Washington, illustrated by the Coast and Geodetic Survey and the Bureau of Standards. On the other hand, in the universities of the country men are engaged in teaching and each year necessarily considering their subjects in the large, and immediate results are not demanded. These universities and the few independent reresearch institutions, illustrated by the Carnegie Institution of Washington and the Rockefeller Institute of New York, are the chief centers for the broader contributions to science and learning.

THE RELATIONS OF TEACHING AND INVESTIGATION

It is my conviction, based upon many years of observation and experience, both in a university and in a department at Washington, that upon the average a man produces the best scientific results who does some teaching. To give a course to a group of advanced students requires that a man go over the subject broadly. Even if the course be highly specialized, a man must consider his material, not only in its interrelations, but its relations to the other branches of his science. One who is a productive scholar scarcely gives a lecture upon a subject which he is investigating without illumination reaching him upon some point. There is nothing more productive of ideas than the presence and inquiries of young and earnest minds. A man who at Washington sits at his desk six days in the week, delving in his subject, often becomes buried in his material. Too frequently he never sees it from the outside. His material masters him instead of him mastering his material. The successful teacher must get outside of his subject, and consider its broader aspects.

I believe that the productivity of the scientific staff at Washington, even from the point of view of immediate results, would be improved during a given period, if each year the men of reputation were each obliged to give one set of lectures for at least a half year, either upon the subject under investigation, or some part of a science related to the investigation. The opening of the scientific bureaus at Washington to such students as are sufficiently advanced to take advantage of the material, and affording opportunity to members of the scientific staff each to give a course of lectures, would greatly improve the efficiency of the bureaus.

However, in order that the lectures may be successful, it is necessary that they be a part of the official duties of the scientific staff, not extra work for additional compensation. At the present time, because of the meager salaries, a number of men belonging in the departments give lectures in George Washington University or other institutions, thereby gaining additional compensation. This is an extremely unsatisfactory condition of affairs, in that it requires teaching to be done in addition to the day's work at the bureau. In order that lectures shall be efficient and the man who gives them gain the most inspiration and the largest broadening effect from them, they should be a part of his regular work. By the proposed combination under which a relatively small amount of instructional work would be given by any member of the scientific staff, I confidently believe that the work of the various scientific departments and bureaus, considering only the point of view of efficiency, would be greatly improved.

Thus in creating the conditions essential for the special national university which should exist at Washington, we should thereby increase the efficiency of the departments.

An incidental important gain which could come from the adoption of the plan proposed would be the training of men to fill the scientific staffs at Washington. Under present conditions, we know the staff contains many mediocre men. While this is partly due to lack of properly trained men of ability, it is realized that it is also due to niggardly pay, combined with the high cost of living at Washington. Too frequently a man who develops unusual ability in a bureau either goes to a university where he obtains better financial terms and more favorable opportunities for scientific work; or, because he can not decently support a family upon his salary, he goes into some profession or business in which he can apply the knowledge he has obtained in a department.

THE REQUIRED MACHINERY

We now have the fundamental facts before us. Not to arrange so as to utilize to its highest efficiency the vast wealth of material for scientific research at Washington is nothing short of improvident and reckless waste of great opportunities. It is a wrong to a member of the staff to demand that he grind away at his practical problem year in and year out without giving him a chance for a larger view through instructional work.

If the above conclusions be accepted, the next question to be considered is the machinery required in order to secure these desirable ends. It may be said at the outset that for the national university here advocated, while some money must be available, no large appropriations are necessary. The institution must have an executive officer. Under him must be a staff, the duty of which shall be to learn all of the scientific possibilities of the various departments and bureaus, to advise students who come to Washington, and to arrange for their work. It should be the further duty of the administrative force to prepare announcements of the courses of instruction which are to be given, with descriptions of the material available for such courses, precisely as is done by each in the universities.

The administrative force of the national university, if desired, might be associated with the bureau of education; indeed, this would seem to be a very natural association. If this suggestion be accepted, the administrative staff and bureau of education could both be housed in a single building and such cooperation established between the two as would be to their mutual benefit.

For the above work an administration building or a part of a building is necessary. Temporary quarters should be rented, and later, when experience shows achieved results warranting the expenditure, an appropriate permanent building should be constructed. In the administration it would be necessary to provide some lecture rooms, although the halls in the National Museum and in various other public buildings should be utilized for the larger lectures. The men who give specialized courses to small groups of students probably would prefer to give them in the building in which they work; for there would be the materials and the special libraries. This would require merely that each bureau or institution, illustrated by the Naval Observatory, the Geological Survey, the Bureau of Animal Husbandry, set aside one room of moderate size for lectures.

One of the obstacles in the way of the highest success of the plan is the insufficient housing of many of the departments; but the obstacle will gradually be removed. This is evidenced by a number of exceptions. At the Congressional Library there is ample space for all the students who may desire to come. In the magnificent new National Museum, where are associated the wonderful collections in geology, mineralogy, biology, anthropology, etc., are the most ample set of workrooms and laboratories anywhere in the country. Scores of students could there readily be accommodated without interfering with the effectiveness of the staff. The Naval Observatory has a splendid new building. The Bureau of Standards has adequate quarters. All these new structures have become available within a few years, and others will undoubtedly exist within a comparatively short time.

EXISTING LAW

Already the principles above advocated have been recognized to a certain extent by Congress through two enactments, the first in 1892 and the second in 1901.

Under these acts the scientific collections, museums and libraries of Washington and their other facilities were made accessible to scientific investigators and to advanced students, "under such rules and regulations as the heads of the departments and bureaus mentioned may prescribe."[3] Apparently the act of 1892 also contemplated that the advanced students who do work in the departments would have the assistance of the members of the scientific staff, for the preamble includes the phrase, "promote the work of education by attracting students to avail themselves of the advantages aforesaid *under the direction of competent instructors.*"

These laws have been taken advantage of to a small extent. As pointed out by President Hadley, their main service has been to men who are already trained for their work and are competent to carry on investigations independently of direction. These men have simply come to Washington and there used for their ends the material which the departments have afforded. For advanced students who still need the guidance of formal instruction the effect of these laws has been so small as to be almost negligible. Substantially the only exceptions are the one or two departments in which the scientific staff have voluntarily as a part of their duties given instruction either to the younger members of the staff in order better to fit them for their work, or to outside men. The best illustrations of this are furnished by the Bureau of Standards, the Public Health and Marine Hospital Service and the laboratories of the Bureau of Fisheries at Woods Hole and Beaufort.

EXPLANATION OF MEAGER RESULTS

That no large results have come from the acts mentioned, one of which has been a law for more than ten years, might be regarded as evidence that the position above taken concerning the desirability of making the opportunities at Washington available for scientific work is unsound. However, it is obvious that the failure of these laws to produce marked effect is due to three reasons.

1. There is no information published describing the facilities for research at Washington and the different lines of work which may be there profitably pursued.

2. There has been available no single bureau to which application can be made for the use of the facilities, no one to guide the work of the advanced students, no one to correlate the different lines of work. It is perfectly futile to suggest that a student go to Washington, enter a bureau, tell some official that he has come to take advantage of the provisions of the laws mentioned. This a man would not do; and if he did so the chances are that he would gain very little satisfaction by so doing, for he would be lost in the mazes of the bureaucracy. As President Hadley puts it: "The student who comes to Washington to-day to get his scientific training in the government departments comes under his own impulse and at his own risk."

3. For effective advanced work it is necessary that regular instruction be given. The existing laws do now provide for such instruction. If the proposal be accepted that members of the scientific staff be permitted as a part of their duties to give a limited amount of instruction, this fundamental necessity for successful advanced work is met. In this connection it is notable that in those instances where instruction has been given by the members of the staff, illustrated by the Bureau of Standards and the Bureau of Fisheries, the facilities for advanced instruction have

[3] Anno. Fed. Stat., Vol. II., pp. 860–861 (Edward Thompson Company).

been taken advantage of. It seems to me that these cases in which important scientific results have followed systematic instruction furnish conclusive evidence that if the principles applied in these bureaus were extended to other bureaus, the facilities and opportunities would be taken advantage of upon a considerable scale, perhaps as great as their facilities permit.

Therefore, if the opportunities for scientific work at Washington were as definitely described as are the courses in the catalogue of a university, if there was a central place to which a man could go to register and be guided to his work, if he could have an opportunity to have his work correlated, if he could have the assistance of the man with whom he wished to work, then I confidently believe that there would be a very large number of students who would take advantage of the unexampled collections and libraries of Washington.

To make these facilities still more available, it would be advantageous for the various universities of the country to cooperate with the Washington authorities. In the catalogue of a university it might be well to announce the particular lines of work and the advanced courses which could be advantageously taken at Washington best to supplement the work done at the university. Such cooperation would even more clearly emphasize the fact that the plan for a national university at Washington is not one to compete with existing universities, but to supplement them. Of course, no university could be compelled to cooperate as suggested, but it can scarcely be doubted that a large number would enter into cooperation, since so doing would be to the advantage of their students. Thus it is believed that the proposals made, if adopted, will result in a great gain to science in the country and also be of direct advantage to existing universities.

It is to be noted that the plan outlined does not include that of granting degrees. The fundamental thing advocated is that the country gain the advantage of the opportunities which exist at Washington, which they may do with comparatively little additional cost. To accomplish this it is not necessary that the departments undertake the task of examinations, the approval of theses and the awarding of degrees.

If there be prejudice against calling the institution above described a national university, it may be given some other name, since as a matter of fact the institution proposed would be different from any existing university in that it would not profess to give a complete system of courses regarding any subject, but would give such specialized courses as the facilities at Washington made advantageous; and also it differs from a university in the respect that it would not grant degrees. For my own part I do not particularly care whether or not the institution of which I speak be called a national university; but I am most anxious that the great opportunities at Washington, both in the way of materials and men, shall be available as instrumentalities for advanced research, and that this shall be a national asset.

PROPOSALS APPROVED BY STATE UNIVERSITIES

The proposals made are in perfect harmony with the plan for the establishment of a national university, approved by the National Association of State Universities. In the bill introduced into Congress with the sanction of the association, it is proposed that the essential idea of the national university be opportunity for study, not the granting of degrees. It is further proposed that no student shall be permitted to work in the various departments until he shall have had the degree of master of science or arts, or equivalent training. This would require that a man shall have his first degree and shall have pursued graduate studies for one year and thus have gone far enough in advanced work to become qualified to begin a piece of special investigation. After a student has continued his work at Washington to the point where he should have a doctorate, he may take his examination and qualify himself for his doctorate at the institution at which he previously studied, and thus add to the prestige of that institution. Naturally, a part of such qualification would be a thesis prepared by using the material in the bureaus and departments. If the universities outside of Washington should cooperate with the Washington scientific staff, a student at Washington might be to a certain extent under the guidance of the university from which he came, and by this means his entire graduate work be made a harmonious whole.

NOT A RIVAL TO EXISTING INSTITUTIONS

Thus the proposed national university would not be a rival to existing institutions, but supplementary to them; not supplementary to one of them, but supplementary to all. In Germany it is the habit of students when studying for a doctorate to spend a part of the time at one university and a part at another. In some cases the work for the doctorate may be done at more than two institutions. The plan to have the departments at Washington available for advanced work would undoubtedly result in giving to many students a broader training than they now secure because of the fact that they would do a portion of their advanced work in a university and a part in the research departments at Washington. This arrangement would be most advantageous, for a part of the work would be done in institutions where the spirit is that of a university, and part in the bureaus where the spirit is that of immediate results; and it is the combination of the ideal and the practical in a man's education which gives the highest capacity for future useful service to the nation.

SUMMARY

In summary, (1) It is proposed that the unapproached wealth of books and materials at Washington for research be made available to the advanced students of the country having the baccalaureate degree and one year of graduate work or its equivalent.

(2) It is proposed that the scientific staff at Washington be authorized as a part of their official duties to give a limited amount of instruction.

(3) It is proposed to establish an administrative division, the duties of which shall be to make the facilities of Washington known and to guide the students to them. If desirable this division may be made a part of the Bureau of Education.

(4) It is proposed that a student completing his work for a doctorate at Washington be granted his degree from the institution from which he came.

(5) It is proposed that existing universities cooperate in this work with the departments at Washington.

If this plan be adopted, it can not be gainsaid that science in America will receive a great impetus; that the scientific bureaus at Washington will be inspired to escape from their bureaucratic bonds at least in some measure, and if so they will make larger contributions than heretofore to the advancement of learning. All the above results may be accomplished by a relatively small expense and to the mutual advantage of the United States departments and existing universities.

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University of Wisconsin

THE NATIONAL UNIVERSITY[1]

I HAVE been asked to make an address upon the relation of the National Association of State University Presidents to the movement for the establishment of a national university.

I desire to say in the first place that, apart from the facts which I shall give concerning the action of the association, I shall be presenting my own ideas. I believe they represent fairly well those of my colleagues in the association, and yet as they have not been presented to them for their criticism or endorsement, I wish it to be distinctly understood that I am speaking for nobody but myself in the argument which I shall present on this subject.

After the fullest and most careful discussion of all phases of the subject the National Association of State University Presidents has repeatedly endorsed the project for the establishment of a national university.

This means a university established by the federal government of the United States, deriving its support primarily from the federal treasury, subject to the ordinary control which a free government exercises over its organizations and their work.

I desire to lay down two or three propositions which seem to me fundamental in securing a proper position from which to judge this whole question. My first proposition is, that in a free state education is fundamentally a national function. I do not mean by this that it is necessary for the federal government of such a free state to regulate, control or support education; though it may be desirable that it should do so. If the locality or the state, or the two together, in a country like ours, will provide adequately for this national function, it may be properly enough left to them; but if they either do not or will not provide for it, then the federal government itself should undertake to see that provision is made. I mean, therefore, that education is a national function in the sense that it is of fundamental importance to the nation as a whole; that it should be properly performed, and if there is no other way to secure its proper performance except through the cooperation of the federal government, then we should have this cooperation.

I maintain that in a state like ours, education is a national function; because to the permanent endurance of a republic, popular education is an absolute necessity, and if it can not be obtained by one form of governmental organization, then it must be obtained by another, or the nation will suffer the consequences. No free government can long exist which is based upon an illiterate people—nay, I believe we may properly paraphrase Lincoln's great expression on another subject, that this government can not remain permanently free if it is based upon a population half literate and half illiterate. All the people must become educated to the necessary extent to secure the basis for democratic government, or in a certain sense, all will become uneducated, *i. e.,* the value of the educated half will be largely lost, *i. e.*, will fail to secure that degree of education necessary for the preservation of a free state. Now that is a national function, to my mind, in its nature, the adequate performance of which is essential to the existence of a nation. From this point of view, education, after the national defense, is the most distinctly national function of all the functions which our society has to perform.

But education is national in its nature

[1] Abstract of an address delivered before the National Education Association at Chicago, July 8, 1912.

from another point of view and should be recognized as such in the organization of our government. The advantages given by elementary and secondary and higher schools are not limited to the communities which support them. A little red school house upon a lonely hillside of a New England state may train the man who will head a great movement for reform and progress in a distant state beyond the Rocky Mountains. The people of the latter state profit by the education which that man obtained at the expense of that New England district, and they should, by all standards of fairness, contribute their part toward the support of the school which produced him. In fact, I think it is not too much to say that, taken broadly, the history of this country during the last two generations demonstrates that in many cases the chief advantage of the school system of a community has redounded to the benefit of other communities in which the particular boys and girls educated in these community schools have subsequently spent their lives and done their work as members of society. Now if all sections of the country profit by the existence of educational advantages in any one community, so the country and the nation, as a whole, should be expected to do its part in developing and supporting these local facilities for education.

There is another reason why education is in its nature a national and not a local or state function, and that is that the disadvantages of the lack of facilities and the lack of schools are not limited to the communities which suffer such lack of school facilities to exist. You hear a man say sometimes that it is up to the community to keep its school, and if it doesn't wish to keep one, let it suffer the consequences. But the same thing is true here as in the case just mentioned, the evil results of inadequate school facilities do not accrue alone to the communities which neglect such matters, but are liable to be of the most serious consequence to other and distant communities; because under our scheme of life, the ebb and flow of our population is so continuous and so extensive that the boys and girls who have missed the opportunity for the highest development, owing to the lack of these local facilities, become members of other communities and go into them and into their work weighted down with all the ignorance and apathy and indifference to higher things which is characteristic of an ignorant population as a whole. So that alike by the distribution of its advantages and the distribution of its disadvantages, popular education is in its nature a national function and not merely a state and local function, and consequently, unless the locality and the state can and will perform this function satisfactorily, the nation must come in as a unit and through its organized representative, the federal government, contribute its share in this way to the support of this common institution.

We must not lose sight of the fact that it is, after all, the American people, as a whole, that pays the bills. It is not the nation distinct from the state or the state distinct from the locality; but it is the locality and the state taken in their totality which make up the nation; and it is therefore a mere question of expediency through what organ and to what extent the people will exercise their power for the purpose of promoting the public welfare.

Now there is another important reason why the people of the United States should aid the cause of education through their federal government as well as through their state and local government, and that is that the people, as a whole, can do certain things through the cooperation of their federal government which they can not do through their state government or through their local government alone. The expense of an adequate educational system is enormous, and grows continually with the rising standard of the people as to what satisfactory education is. An adequate revenue system will draw upon national sources of revenue through the federal government, upon state sources of revenue through the state, upon local sources of revenue through local government. Some sources of wealth may be more easily and efficiently tapped through the federal government than through the state or local government, and *vice versa*.

In our scheme of federal government in this country, we handed over to the central authority a revenue power—I will not say more than adequate for the federal purposes which we incorporated in our constitution, but I will say more adequate to accomplish the national ends contemplated in the law than were given either to the state or the locality. The federal government can raise funds in many respects more easily than either the state or the locality. And a sound financial system demands that that element in our system shall raise the revenue which it can raise most easily, and then that a reasonable distribution of the revenue so raised among the various federal functions and among the state and local functions shall be made.

I think our history has demonstrated clearly enough already that education can never be properly cared for in this country unless we draw upon national sources of revenue as a means of assisting in its support.

Owing to history which I need not recount, the southern states, for example, find themselves in the position of having two independent and complete systems of education, for the white and colored races, respectively. It is quite unreasonable to hope that in our day and generation the southern communities will be wealthy enough, or, what amounts to the same thing for our purpose, will think they are wealthy enough, to care adequately for these great interests, and if the people will not utilize their other sources of revenue and their other organs of government to assist in providing a part of the means for the solution of this problem, we shall still continue to suffer as we have suffered for generations by this situation.

My next proposition is that this country can not solve its educational problems in the large until it recognizes that education is the business of the nation and that pecuniary assistance for its support in a large way shall come through the organs of the nation as a unit.

We can not get the money in any other way. We refer, of course, by preference in our educational discussions to the unhappy educational conditions of certain portions of the South. But the conditions are just as really and just as truly inadequate over whole sections of the northern states as they are in the south. We need not go out of the state of Illinois itself to find schools which do not deserve that name. We need not go outside of Illinois to find local communities which, after taxing themselves to the limit which the law allows, still have not sufficient money to maintain, during the months in which a child ought to be in school, the kind of school which it is worth the child's while to attend.

There is another important matter which we ought not to lose sight of. Great national issues are pushed forward only when it is possible to secure national attention for them; only when they have become national in a formal as well as an informal way; only when the nation is discussing them as great national issues. If we could get national attention concentrated upon our educational problems year after year as one of the fundamental issues going to the very life of the nation itself, we should make vastly greater progress than we do. And this attention we shall get when we recognize the essentially national character of education by making educational policy a part of national policy. When the federal congress discusses educational questions as fully, as completely, as they discuss questions of defense and the tariff and internal improvements, we shall be in a way of securing for educational issues that attention which is necessary to their continuous and rapid solution.

Intimately connected with this fact, namely, the necessity of securing national attention for the consideration of national problems, if we wish to hasten their solution, is the further one that we could advance with far greater certainty and with far greater speed, our national standards, *i. e.*, the standards of the people taken as a whole and in their local organizations, if we can get before the nation, as a whole, a proper standard of what education means and what education ought to mean.

The nation then, and not merely the local school district or community or state, must become an educational unit in all grades of education.

It has already become so to a certain extent. It is becoming so more and more every passing day. Unequally, it is true—in spots only—here and there, but steadily and persistently. The federal government has granted lands for the support of elementary education in nearly all the states of the union within whose territory were to be found large stretches of government-owned land. In fact the federal grants were the foundations of the school funds in the vast majority of the states of the union. But the federal government has not been content with this. It began some fifty years ago the policy of developing within each state in the union a higher institution of learning supported in large part, first by federal grants of land; second, by the grants of money realized from the sale of lands; and finally, by grants of money raised by the general revenue system of the government. To-day we have sixty-seven such institutions which owe a part, or the whole, of their income to the action of the federal government. The aggregate value of the permanent funds and equipment of these land grant colleges themselves exceeds to-day $125,000,000. The total income of these institutions in 1910 was nearly $23,000,000. It would take an endowment fund of over $450,000,000 to produce this income.

We take pride here in Illinois in the fact that it was an Illinois farmer and professor who first formulated this plan, and that the legislature of Illinois was the first American legislature to stand strongly behind this policy of federal grants to higher education within the states. It has become the greatest scheme of an educational endowment which the world has ever seen. The federal government itself contributes only a small part of the total funds necessary for the support of these institutions, but it was the giving of that small part which made the rest of it possible, which stimulated local and state interest, which by fixing national standards stimulated the nation to rise to these standards. I have very little doubt myself that if it had not been for the action of the federal government in making these appropriations for the development of agriculture and the mechanic arts within the states, we should be a whole generation behind what we are in the development of our educational system.

Incidentally, I may say that the House of Representatives of the Illinois legislature has again led the way in urging upon the federal government the necessity of large additional grants for educational purposes by sending to congress a unanimous petition, as follows:

Whereas, The legislature of Illinois by the joint resolution of February 8, 1853, was the first among the American legislatures to petition the congress of the United States to make a grant of public land for each state in the union for the liberal endowment of a system of industrial universities, one in each state, to promote the more liberal and practical education of our industrial classes and their teachers; and,

Whereas, The congress not only made a liberal grant of land in the year 1862 for this purpose, but has also followed up this policy once begun by still more liberal appropriations for the support of higher education in agriculture and the mechanic arts, resulting in the great chain of colleges for agriculture and the mechanic arts to be found in every state and territory in the union; and,

Whereas, The time has now come for the adoption of a similar policy in the field of elementary and secondary education; therefore, be it

Resolved, By the house of representatives of the state of Illinois, the senate concurring herein, That the congress of the United States be respectfully petitioned to appropriate annually to each state and territory in the union a sum equal to one dollar per head of the population of said state or territory as ascertained by the last census, for the purpose of establishing, maintaining and extending in the elementary and secondary schools of said states and territories, while not excluding other elementary and secondary subjects, such practical, industrial and vocational training, including agriculture, the mechanic arts, domestic science, manual training, commercial subjects and such instruction in other similar subjects of practical nature as the interests of the community may seem to demand; and

Resolved Further, That our senators in congress be instructed and our representatives be requested to use their best exertions to procure the passage of a law of congress donating said sum to each state and territory in the union for said purpose; and

Resolved Further, That the governor of this state is hereby requested to forward a copy of the foregoing resolutions to our senators and representatives in congress and to the executives and legislatures of each of the other states and territories, inviting them to cooperate with us in this meritorious enterprise.

I wish to emphasize again very strongly that national aid to education, whether lower or higher, does not necessarily mean excessive federal centralization and control. The extent to which the federal government shall have control of the funds which it devotes to education is a matter of expediency to be settled from time to time and from generation to generation, as national and local needs and possibilities may dictate.

I should like to call attention to one other fact, and that is that the federal government, when it wished to develop, by the expenditure of a comparatively small sum of money, a system of educational institutions which should have a profound effect upon the development of elementary and secondary education, it chose to establish colleges, not high schools; colleges, not grade schools; colleges, not kindergartens. In other words, it recognized that in the development of any educational system in a country, progress goes often from the so-called higher to the lower. You can not develop a good high-school system unless you have a good college system which can supply the necessary teachers, the necessary guidance, the necessary stimulation, the necessary leadership. You can not have good grade schools unless you have good high schools which furnish, taken as a whole, the training of the teachers employed in these elementary schools. The converse is, of course, equally true, that you can not develop your college beyond a certain low level of efficiency unless the high schools can be brought up to a high level. Nor can you raise the level of your high schools to what it ought to be unless the grade work is done properly.

I desire again to call attention to the importance to educational advance of securing a national formulation, a national organization of the educational idea and educational ideal.

There is a subtle moral and psychological reaction upon the people, as a whole, arising from the formulation and incorporation of a national ideal in a practical national policy which spells progress and success for movements which are able to find such national expression.

As suggested above, when education is as regularly the subject of national debate and national conflict as the tariff, banking and currency and internal improvements, we shall take another long step forward in our educational development.

What I have thus far said applies to all grades of education alike, and it is upon this foundation that in my advocacy of a national university I take my stand. If the views thus far advanced command your assent, I believe I shall have your consent to the further proposition I advance, namely, that one of the essential elements of our American system of education is the kind of a university which the federal government can build and which shall stand, so to speak, at the apex of our educational pyramid, or if you choose to reverse the simile, it is all one to me—which shall be the foundation stone upon which the pyramid of national education shall be erected; for all history shows that from the universities, from the highest schools, have gone forth steadily those influences which have molded and shaped and fashioned the popular education in all times and in all countries.

I mean by a national university, an institution sufficiently like the ordinary institutions with which you are all acquainted to be thoroughly familiar to you. A teaching and training, as well as an investigative institution, manned with the best men in all departments in which the human intellect has exercised itself, drawn from the entire world, equipped with all that money can provide, for the purpose of stimulating and increasing our interest in the world of the spirit and the world of sense about us.

Now one of the fundamental purposes of a university system is to beget, diffuse and establish, in the mind—nay, I will say also in the heart of the people, the scientific spirit and the scientific method. If this can be accomplished, the face of the world will be changed. Now this can be done in certain respects more easily and more thoroughly and more rapidly by means of a system of state and national universities than by any other means.

In what I am about to say I am not animated by any spirit of opposition to the historic, private institutions of this country. He would be an ungrateful American indeed who would cast any slur upon Harvard and Yale and Princeton and the scores of more recently founded private universities, like Hopkins, Chicago and Leland Stanford and Northwestern, which are such an honor to our country and our civilization. I should certainly consider myself an ingrate if I should say anything derogatory of Harvard or Pennsylvania or Chicago or Northwestern, where as student or professor or president I had an opportunity to prepare myself for public service, and to have had some small part in the glorious work of these institutions. All honor to them, and increasing power and glory and prosperity! But, friends, however great they may become—and may their shadow never grow less—they can never accomplish the purposes we have here in mind, namely, to incorporate in a visible form the national ideal of university education.

I have long been a warm admirer of President Eliot, in many respects the greatest figure in American education. He was kind to me personally when I was a freshman at Harvard. He was for more than a generation my guide, philosopher and friend in the field of university education and administration. I think it is not too much to say that he revolutionized it to its great betterment.

But I know no more striking illustration of the fundamental weakness that doth beset us all, than President Eliot's notion that he could make of Harvard a national university in the sense that we have been using the term here. That he could make a private institution, dependent for its resources upon the liberality and self sacrifice of alumni, however generous they may be, or upon the whims of rich men, however numerous they may be, situated upon the edge of the country, even though in such a glorious city as Boston, that he could make an institution so located, and so fathered and mothered to be that embodiment of our national ideal of science and education and art which we are looking for. Other men have or have had the same notion for their institutions. Idle and vain hope! Neither Harvard nor Yale nor Columbia nor Princeton, nor all of them taken together, great as is their function, great as is their service, can hope to do this particular service for this country. Nor Mr. Rockefeller nor Mr. Carnegie nor both of them together, though multiplied by five and animated even still more fully than at present by patriotic unselfishness and far-sighted motives, can do this thing for the nation which, after all, only the nation can do for itself. The state universities of Michigan and Wisconsin and Minnesota and Illinois and the forty others—no one of them alone nor all of them together, great as they may become—and we are all headed for great things—can hope to fill this place, incorporating in themselves, in such a way as to satisfy the national longing, that deep-felt, that unexpressed ideal of university education.

The reason is simple. No partial expression will satisfy this longing for wholeness. When that which is perfect shall have come, that which is imperfect will unite with it and help constitute its perfection—private and state institution, with the national university—making one complete system, or it will dry up and disappear. When that which is complete shall have appeared, that which is incomplete must become a part of it or be sloughed off or cast into the scrap heap. No national university can exist except as the creation and organ of the national will, shaped and directed by it. Supported and sustained by this national will, it will be the expression of you and me and all of us, we a part of it and it of us.

Such an institution would not injure, but benefit every private and every state university, by its superior support, by its superior prestige, by its greater wealth. It would strike the popular imagination of this country in such a way as to give to the university idea itself an enormous impetus, the reflex effect of which would show itself in the increasing prosperity and development of every private and state institution.

The foundation of Leland Stanford did not injure the University of California, but helped it immensely. The foundation of the University of Chicago did not injure Illinois or Northwestern or Michigan or Wisconsin, but by the bold and striking way in which it raised high aloft the standard of science it gave an impetus to the university idea which made the work of every one of these institutions more adequate and more easy.

The same thing would be true in a larger degree of a national university, organized along proper lines, and put under proper influence.

Such a national university as I have suggested, located at the site of the federal government, supported by appropriations from the federal treasury, controlled and regulated by federal law, would easily become, as it ought, the crowning institution of our university system, private and state alike. It could supplement the shortcomings of our other institutions as well as emphasize their excellencies. It could undertake many enterprises of national scope, and which no existing single institution, public or private, can afford to undertake. It could offer to our best qualified young men and young women, opportunities which only a nation like ours can afford to offer.

Such an institution, located in the national capital, would exercise a vigorous and salutary influence on the course of federal legislation itself. Its pointed spires and gilded domes would of themselves be powerful, though mute, monitors calling attention to the claims of science to be the guide of legislations.

Such an institution located in the center of political power of the greatest nation on earth would attract in large numbers the bright and promising youth of other countries, who, as students here, would imbibe those fundamental American ideas which we fondly believe are destined to work out the salvation of the world when they shall have done their perfect work, while these youth would gain added respect for our society and our ideals, which, carried back home and incorporated in their own policies, would contribute powerfully to that mutual understanding which is the surest basis for international peace.

Such an institution located in Washington could utilize for purposes of instruction and investigation the wonderful resources heaped up by the government of the United States in its scientific departments. The National Library, the museums and collections of all sorts lie largely fallow at present, waiting for the people of the United States to make their utilization possible in the various schools and colleges of a national university.

Such an institution, located at such a strategic point, will wield a subtle, ever deepening and widening influence over the whole American people in the direction of increasing their interest in science and their belief that science is an important element in private and national life. It will be their university, and they will come to take an increasing pride in, and appreciation for, the work it is doing; and thus will, by this reflex effect, be trained to gradually entertain an ever deeper respect for the standards and ideals of higher education itself.

Friends, such an institution is coming, as surely and irresistibly as the tides of ocean. Will you help it, or will you oppose it, or, worse than either, will you do nothing?

This National Education Association could secure the establishment of this institution in a short time if it would only go after it in earnest.

Ignorance and apathy and prejudice have thus far been most potent in preventing the realization of this dream of Washington.

Private institutions, religious and secular, have opposed, thus far successfully, the movement. Private institutions, men of wealth, men of no wealth, men of ideas, men of no ideas, have set themselves against this project. It is up to you and the like of you to help bring this about in our day and generation.

This great power can be set to work immediately in the interests of science and art and education, supplementing, reinforcing our defective and weak system of education. Every day its coming is delayed represents so much pure loss to the causes in which you are interested; to the welfare of this nation, and to civilization in general by all that it might contribute if it were now at work.

This institution, this national university, would be one of the most important elements in making this nation of ours in reality what it is in our dreams and hopes and fond anticipations, the leader of the world in art, in science and education, and in civilization.

Edmund J. James
University of Illinois

SCIENTIFIC NOTES AND NEWS

Dr. Anton Fritsch, director of the zoological and paleontological division of the Museum at Prague, has celebrated his eightieth birthday.

Sir William Ramsay has been elected a foreign associate of the Paris Academy of Medicine.

Dr. A. Engler, professor of botany in the University of Berlin, has been elected a corresponding member of the Paris Academy of Sciences.

George Amos Dorsey, associate professor of anthropology in the University of Chicago, who has recently returned from a three years' tour of the world and investigations in his special field of research, was given a banquet in Chicago on July 30 by the directors of the Chicago Geographical Society, of which Dr. Dorsey was at one time president.

Dr. John K. Small, head curator of the museums and herbarium of the New York Botanical Garden, was given the honorary degree of doctor of science at the one hundred and twenty-fifth anniversary of Franklin College, Lancaster, Pa., on June 13.

Dr. D. H. Scott, president of the Linnean Society of London, has been elected a foreign member of the Academy of Sciences at Copenhagen.

Sir Patrick Manson has retired from the position of medical adviser to the Colonial Office, and has been appointed a Knight Grand Cross of the Order of St. Michael and St. George in recognition of his eminent services in connection with the investigation of the cause and cure of tropical disease.

The Moxon gold medal for research in clinical medicine has been awarded by the Royal College of Physicians, London, to Sir David Ferrier, F.R.S., and the Murchison memorial scholarship, founded in memory of Dr. Charles Murchison, has been awarded to Dr. W. Rees Thomas.

Dr. Joseph H. White, of the United States Public Health and Marine Hospital Service, has been asked to become a member of the Boston board of health to act as an expert in the health department.

At the recent annual meeting of the Imperial Cancer Research Fund in London Dr. William H. Woglom, of Brooklyn, was appointed first assistant in New York, a position maintained under the Crocker Fund for the Investigation of Cancer. Dr. Woglom was sent to London by the directorate of the Crocker Fund to pursue a course of studies under Dr. Bashford, director of the Cancer Research Fund.

Dr. Edgar W. Olive, professor of botany in the State College of South Dakota, has been appointed curator in the Brooklyn Botanic Garden.

Mr. Herbert E. Ives has resigned his position in the Physical Laboratory of the National Electric Lamp Association in Cleveland to accept the position of physicist of the United Gas Improvement Company of Philadelphia, where his work will consist of consultation and research in connection with the measurement and utilization of heat and light.

Mr. E. H. Tennyson d'Eyncourt has been appointed director of naval construction to the British Admiralty, Mr. W. J. Berry becomes assistant director and Sir Philip Watts is to be retained as adviser on naval construction.

We learn from *Nature* that Professor L. E. Bouvier, of the Jardin des Plantes, has been appointed "Ray Lankester Investigator" for 1912–13, and will occupy the Ray Lankester table in the laboratory of the Marine Biological Association at Plymouth. At the request of the trustees, the nomination for this first appointment was made by Sir E. Ray Lankester, K.C.B., F.R.S.

Dr. Irwin Shepard, of Winona, Minn., for many years secretary of the National Educational Association, has resigned.

Edwin Brant Frost, professor of astrophysics in the University of Chicago and director of the Yerkes Observatory at William Bay, Wisconsin, has been granted leave of absence for a year by the trustees of the university.

Professor J. C. Arthur and Dr. F. D. Kern, of Purdue University, Lafayette, Ind., are spending July and August studying the plant rusts of Colorado, especially along the lines of the Denver and Rio Grande Railway in the southern half of the state, where the problems of association and distribution of species are unusually well presented.

Dr. E. B. Copeland, dean of the College of Agriculture, Los Baños, P. I., who has been visiting the United States, returned to the Philippines at the end of August.

Commander Evans, R.N., of the British Antarctic Expedition, has left England for New Zealand, where he will resume command of the *Terra Nova*, which will proceed to the south polar regions to meet Captain Scott and his party.

Professor C. Juday, of the University of Wisconsin, gave two lectures on the physics and chemistry of lake waters and their biological significance during the latter part of July, at the Indiana University Biological Station, Winona Lake, Indiana.

Dr. Guy Montrose Whipple, of the School of Education, Cornell University, has given three lectures on "The Training of Memory," "The Psychology of the Marking System" and "The Supernormal Child" at the summer session of the University of Illinois.

Professor Eugene Lamb Richards, emeritus professor of mathematics of Yale University, died on August 5, aged seventy-four years.

Dr. Maurice Howe Richardson, Moseley professor of surgery at Harvard University, died on July 31, aged sixty-one years.

The deaths are also announced of Professor Edmund von Neusser, known for his work on internal diseases, at Vienna, and of Dr. Monoyer formerly professor of ophthalmology in the faculty of medicine of the University of Lyons.

The United States Civil Service Commission invites attention to the regular fall examinations for scientific assistants in the Department of Agriculture, to be held October 16–17, 1912. Examinations will be given in the following subjects: Agronomy, dairying, entomology, farm management, forage crops, horticulture, library science, nutrition of man and calorimetry, plant breeding, plant pathology, pomology, seed testing, soil bacteriology, soil chemistry, soil surveying. The commission also announces examinations on September 4, to fill vacancies in the dairy division of the Bureau of Animal Industry, Department of Agriculture, in the positions of assistant dairymen, qualified respectively in market milk investigations, dairy farming and butter making, at salaries of from $1,500 to $1,740 a year.

The sixth Congress of the International Association for testing Materials will meet in New York City from September 2 to 7. The headquarters of the congress are at 29 West 39th St., New York City.

The agricultural bill includes an appropriation of $80,000 on behalf of the Pennsylvania Chestnut Tree Blight Commission for the investigation and suppression of chestnut tree bark disease. The government is authorized to cooperate with the states, including Pennsylvania, which has already appropriated $275,000 for the purpose.

Dr. Wilhelm Paul Gerhardt, of Brooklyn, N. Y., has given a collection of books, numbering 275 volumes, to the sanitary and biological department of the College of the City of New York, and a geographical collection of about 150 text-books and atlases to Teachers College, Columbia University. A third collection of several hundred volumes has been presented to the Illuminating Engineering Society of New York City.

A donor who wishes for the present to remain anonymous, has given the Chancellor of the Exchequer a sum of £10,000, of which £3,000 is to be handed to the National Museum of Wales, Cardiff, £2,000 to the University College of Wales, Cardiff, and £5,000 to the National Library of Wales, Aberystwith.

Under the will of Sir James Inglis, a former president of the Institution of Civil Engineers, the institution has received a legacy of £5,000, to be applied to its new building which is now in course of erection in Great George Street, Westminster, and to which he had during his lifetime contributed liberally.

Nature states that in response to a joint appeal made by the Royal Society of South Africa and the South African Association for the Advancement of Science to the Union government, a sum of £500 has been voted during the current financial year as a grant-in-aid for the purpose of assistance in scientific work in or relating to South Africa. A scheme for the administration of this and future funds available for the same purpose on lines similar to that of the Government Grant Fund of the Royal Society has been prepared by a joint committee representing the two above-mentioned societies.

The report of the American members of the commission appointed by the International Mathematics Congress, held in Rome in 1908, to study the subject of the teaching of mathematics in the several countries has been published for free distribution by the United States Bureau of Education.

A permanent memorial of the recent celebration of the two hundred and fiftieth anniversary of the Royal Society in the form of a volume of collotype facsimiles of the signatures of the founders, patrons and fellows of the society recorded in its first journal-book and the charter-book from 1660 to the present time is to be issued shortly by Mr. Henry Frowde. The work will contain a preface by Sir Archibald Geikie. The third edition, revised and rearranged, of "The Record of the Royal Society of London," is also announced.

We learn from the *Journal* of the American Medical Association that on June 1 the superior health magistracy of Saxony, the *Landesmedizinalkollegium,* was substantially extended and converted into a national health department. Its field includes the making of reports on matters of medical and veterinary interest, the advice of the government in the preparation and execution of sanitary laws, and the supervision and management of the scientific institutes subordinate to it.

Petroleum production in the United States in 1911 surpassed its own record made in 1910 by an increase of nearly 11,000,000 barrels. In 1910 the output was 209,557,248 barrels. The total production of the world also surpassed all previous records, amounting to over 345,000,000 barrels, and of this the United States produced more than 63 per cent. The value of this enormous output of oil in the United States for 1911 was $134,044,752, the average price being 60.8 cents a barrel. Final figures have been compiled by David T. Day, the petroleum statistician of the United States Geological Survey, and have just been made public in a statement issued by the survey. The increase for the year was caused principally by the gain in California, which was by far the largest producer, its output being over 81,000,000 barrels. Another factor in the increase was the discovery of oil at Vinton, La., and the comparatively new Caddo field in Louisiana also grew in importance. A find of high-grade oil at Electra, in northern Texas, was another notable event of the year. With a gain in production of nearly

11,000,000 barrels and with an increase in price at the end of the year, it is evident that an unusual condition in the oil market existed. The three commodities of general market value to be considered in connection with crude oils are gasoline, kerosene and residuals, the last suitable for fuels in the west and for lubricants and wax in the east. In the trade "naphtha" is the name generally applied to oils lighter than kerosene as distilled from crude oil, but by the public the term "gasoline" is applied to the light fraction of the oil suitable for internal-combustion engines. In fact, when crude naphtha is redistilled it is for the most part separated so as to yield gasoline and lighter or heavier kerosene. The demand for gasoline has become so imperative that little or none is now allowed to lower the safety of lamp oils; the latter have therefore greatly improved in character. In the production for 1911 California led with 81,134,391 barrels; Oklahoma took second place, with 56,069,637 barrels; Illinois was third, with 31,317,038 barrels; and Louisiana was fourth, with 10,720,420 barrels. The prices of the different oils varied greatly, ranging from 47 cents to $1.32 a barrel. Thus while the production in Pennsylvania was only 8,248,158 barrels, its value was $10,894,074, whereas Louisiana, which produced 10,720,420 barrels, received for it only $5,668,814. The greatest increases in production in 1911 were in California, 8,123,831 barrels; in Oklahoma, 4,040,919 barrels and in Louisiana, 3,879,025 barrels. The principal decreases were in Illinois, 1,826,324 barrels, and in Ohio 1,099,258 barrels. The following table of total production shows the general increase in production for the United States since 1901.

1901	69,389,194
1903	100,461,337
1905	134,717,580
1907	166,095,335
1909	183,170,874
1911	220,449,391

According to *Terrestrial Magnetism*, preparations are being made, under the superintendence of Professor Tanakadate, to send out four parties for making a new magnetic survey of Japan, to be completed within two years. The same general scheme of work will be followed according to which the first survey of about eighteen years ago was successfully accomplished under Professor Tanakadate's direction. The issuing of the British Admiralty chart of lines of equal magnetic declination has been recently transferred from the Hydrographic Department of the Admiralty to the Magnetic and Meteorological Department of the Royal Observatory, Greenwich.

UNIVERSITY AND EDUCATIONAL NEWS

It is reported that Mr. P. A. B. Widener, of Philadelphia, has increased to one million dollars his gift to Harvard University for a library building in memory of his grandson, Harry Elkins Widener.

The late Dr. John Dixon Mann, who occupied the chair of forensic medicine in the University of Manchester from 1892 until his death last April, bequeathed to the university the sum of £1,000. By resolution of the council, the money has been added to the special fund for the encouragement of medical research.

At the University of California work has begun on a laboratory for the Citrus Experiment Station at Riverside, funds for this building and for the site on which it stands having been appropriated by the last legislature. The new laboratory will be thoroughly equipped, and will become headquarters for some of the work for advancing the interests of the orange and lemon industries heretofore carried on by the university at Whittier. The United States Department of Agriculture will cooperate with the university at Riverside, stationing there agricultural experts to study the problems of the citrus industry. Professor J. Eliot Coit has been appointed director of the laboratory.

Nature states that the establishment of the new university in western Australia is progressing satisfactorily, and the senate is open to receive applications for the filling of eight professorial chairs. Parliament has voted an annual minimum endowment of £13,500 towards the administration and needs of the university, and the chair of agriculture has been fully endowed by the newly appointed Chancellor, Sir W. Hackett. Mr. H. Gunn, who carried out similar work in South Africa with success, has been appointed organizer of the university, and is now actively engaged in making preparations for the inauguration of the institution early next year.

Dr. B. E. Ray, at present of the Experiment Station and College of Agriculture, North Carolina, has accepted a position as professor of chemistry in the College of Agriculture and Mechanic Arts, Mayaguez, P. R. Special attention will be given to the development of courses in sugar chemistry.

Professor I. F. Lewis, Ph.D. (Hopkins), of Randolph-Macon College, Ashland, Va., has accepted a call to the assistant professorship of botany at the University of Wisconsin.

Mr. J. W. Merritt, assistant in mineralogy at Northwestern University, has been appointed instructor in geology at Dartmouth College.

At University College, Reading, Dr. S. M. T. Auld, lecturer in the chemical department of the Southeastern Agricultural College at Wye, has been appointed professor of agricultural chemistry, and Mr. John Goding, of the Midland Agricultural College, has been appointed research chemist in dairying.

H. Maxwell Lefoy has been appointed professor of entomology at the Imperial College of Science and Technology, South Kensington, London.

Professor Johannes Fitting, director of the State Botanical Institute at Hamburg, has been called to Bonn, as the successor of Professor Strasburger.

DISCUSSION AND CORRESPONDENCE

THE CORROSION OF IRON AND STEEL

To the Editor of Science: In the issue of Science for April 26, 1912, appears a review of a recent book, "The Corrosion of Iron and Steel," by J. Newton Friend, Ph.D. The review is signed "William H. Walker." The writer did not see this review at the time it was issued in Science, but his attention has just been called to it in a curious way. It appears that the review has been reprinted in pamphlet form for distribution as a commercial argument. The commercial argument is based upon the following paragraph from Professor Walker's review:

> It is a matter of regret that the author has been misled, as have also the reviewer and others, by giving credence to statements and data supplied by the American Rolling Mill Co., of Middletown, Ohio, which he publishes on pages 114, 250, 276 and 351, regarding the purity of this firm's products. For example, the material said to have the analysis published on page 114, as containing 99.954 per cent. iron, and which on page 276 is proposed as a standard for pure iron on which to base a corrosion factor, *was later found by the author himself, much to his surprise, to contain .172 per cent. copper.*

In the commercial reprint referred to, the portion of the quotation from Professor Walker's review which the writer has italicized, appeared in large block letters. There is only one inference that the reader of this pamphlet could form, which is that The American Rolling Mill Co., of Middletown, Ohio, is purposely putting copper into their material for some ulterior purpose.

The writer must express himself as being surprised, to say the least, that Professor Walker should have included in a review of a scientific book such a paragraph as this, based upon an analysis of a single open market sample which was manufactured in the early days of a new industry. Professor Walker must be well aware of the situation with respect to the elimination of copper from iron in the open hearth furnace, for under date of March 16, 1911, the writer wrote to Professor Walker as follows:

> In regard to the point you raise about copper in ingot iron, I can only tell you that at the time when the American Rolling Mill Co. first adopted the slogan in a trade way, of "99.94 per cent. pure," they had not established their chemical research laboratory and had paid no attention to the possible appearance of small amounts of copper in the iron, which came from the ore and selected

scrap which they, in common with other open hearth people, are obliged to use. They are now well aware that ingot iron carries normally about 0.1 per cent. of copper, although efforts are being made to reduce this, with some success. In the meantime, they are explaining that their "99.94" applies only to the usual impurities which have been discussed in relation to the manufacture of pure irons, such as carbon, manganese, sulphur, phosphorus and silicon.

Since the date of this letter, with the writer's advice, The American Rolling Mill Co. has reduced their purity guarantee to 99.84 in order to be certain to be on the right side with respect to the small unavoidable copper content. As a matter of fact, the copper content of the pure iron product now manufactured by The American Rolling Mill Co. is running normally 0.030 per cent. of copper, or better. The elimination of copper to this small percentage has been a matter that has required expert chemical engineering and very careful buying of raw material. At no time has The American Rolling Mill Co. ever introduced copper into their material except in the case of three experimental heats which were made under the supervision of the writer with the intention of determining what effect, if any, the introduction of small amounts of copper would have upon the qualities of the material. Subsequent tests showed that the introduction of copper into iron served no good purpose, and therefore the effort by The American Rolling Mill Co. to completely eliminate it has gone on with unremitting zeal.

From a commercial point of view, it is perhaps not to be wondered at that the attempt to manufacture an extremely pure iron on the same large scale of operation usual in steel manufacturing should have aroused the bitter enmity and active hostility of competing interests in this country. It is, however, certainly unfair to the efforts which have been made to establish the pure open hearth iron industry for the first time in the United States or, in fact, in the world, to have scientific literature distributed with the intent to produce the impression that the object of the manufacturer is not to produce a pure material but to load it with another metal for an ulterior purpose. If Professor Walker had taken the trouble to inform himself in regard to this question as late as April, 1912, he would have discovered that the normal heats of the pure iron made by The American Rolling Mill Co. do not contain more than .03 per cent. of copper, for any one interested in investigations along this line is welcome to obtain his own samples directly from the mill in which the material is being manufactured.

The total elimination of copper from a highly refined iron is not an easy metallurgical problem. The charge for the open hearth furnace, whether steel or pure iron is to be made in it, is normally a mixture of pig iron and selected scrap. If the object is to refine the mixture so as to produce a commercially pure iron, very special attention has to be paid to the amount of copper which may be carried in the raw material. Open market iron of the present day is likely to carry much more copper than was formerly the case. This is largely due to the fact that the introduction of lifting magnets for loading and unloading, has made available in the metallurgical arts, machine shop turnings and other useful sources of iron. From the conservation point of view, a movement of great value has therefore been developed by the use of the lifting magnet. Since, however, copper is not in the slightest degree eliminated in the refining processes of the open hearth furnace, unusual care has to be taken in selecting raw material, to see that it is not contaminated with copper. Owing to the increased uses of copper and bronze in bearings and other parts of machinery, even so-called "heavy melting stock" is likely to carry unknown quantities of copper. Nevertheless, by careful selection of scrap and pig iron used in the processes, and by paying more for selected materials, it is possible by the exercise of continuous vigilance to keep the copper content down to a minimum point.

It is a curious fact that while The American Rolling Mill Co. has been making every effort to fight copper and keep it at the lowest possible point, a number of the steel manufacturers have been deliberately adding copper to their steel, because it has been found that small amounts of this element caused the metal to be more insoluble in dilute acids. Most investigators agree that an acid test should not be made the sole basis of specification where resistance to atmospheric corrosion is required in the product, but nevertheless the fact that a metal can be shown resistant to the attack of mineral acids has been in the past, and is still, used as an attractive salesmen's argument.

The writer can not help regretting that Professor Walker should have included a paragraph in a scientific review, written in such a manner that it could be reprinted and used in a commercial contest with the object of producing a false impression.

Professor Walker in the same review takes occasion to regret that Dr. Friend had recommended this pure open hearth iron as a possible standard on which to base a corrosion factor. The writer has used this material in this way for some time, and the U. S. Bureau of Standards has recently acquired a quantity of the same metal in which the sum of the total impurities present, including the gases, is less than two tenths of a per cent.

It would appear to the writer that there is such a thing as professional ethics in respect to the scientific treatment of scientific books reviewed in a scientific journal, and that such reviews should not be used to introduce false impressions to be afterwards touted about the country as "salesmen's arguments." It is an unfortunate fact that the development of this new step in metallurgy, namely, the manufacture for the first time of commercially pure iron in the open hearth furnace, on a large scale of operation, should have called forth active enmity from so many unexpected quarters in this country.

Allerton S. Cushman

ITONIDÆ VS. CECIDOMYIIDÆ

A note by Dr. E. P. Felt in Science for July 5 (p. 17) calls attention to a matter somewhat aside from the question of priority in nomenclature, but one which should not be disregarded by zoologists who are striving to attain stability and accuracy in the designation of taxonomic groups. There is much dissension among systematic zoologists regarding the status of Meigen's 1800 names for his genera of diptera which were rechristened by him in 1804. As is well known, the latter names were in common use for a full century and many workers are not in sympathy with those who advocate the adoption of the older, long-forgotten names. Whether the generic name *Cecidomyia* should become *Itonida* depends upon our acceptance of Meigen's earlier names, but no one should countenance the appearance in print of a family name "Itonidæ" in place of the proper form Itonididæ formed from *Itonida.* The international code is very specific on this point, stating that: "The name of a family is formed by adding the ending *idæ,* the name of a subfamily by adding *inæ,* to the root of the name of its type genus."

No one has seen fit to criticize this portion of the code, so far as the writer is aware, and students of these same Diptera have previously used in many instances the carefully formed family name Cecidomyiidæ even though this approaches dangerously near the tabooed "unpronounceable combination" which we are warned diligently to avoid. There has been much laxity in the use of carelessly formed family names by zoologists, particularly Americans, and the writer must plead guilty with the rest.

A little care on the part of systematists will serve to eliminate all such barbaric family names, and would add to the dignity of zoological nomenclature.

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SCIENTIFIC BOOKS

American Permian Vertebrates. By Samuel W. Williston. University of Chicago Press, Chicago, Ill. 1911. Pp. 145 with frontispiece, plates I–XXXVIII, and 32 text figures.

This work from the pen of one of the most eminent paleontologists is bound to attract attention from the clear anatomical descriptions of the forms under review and the conservative stand in the matter of conjectural speculations. The book, as the author says, "comprises a series of monographic studies, together with briefer notes and descriptions, of new or little-known amphibians and reptiles from the Permian deposits of Texas and New Mexico."

The sources of material are mainly three: the University of Chicago collection, made in recent years by field parties under the charge of Mr. Paul Miller or the author; earlier collections of the University of Texas, made by Professor E. C. Case; and finally the great Marsh collection in the Peabody Museum at Yale University, which proves an increasingly fruitful field for research as its varied treasures are brought to light. An interesting comment upon our knowledge of reptilian classification shows that the time is not yet ripe to attempt phylogenies of the groups other than the dinosaurs, crocodiles, phytosaurs, pterosaurs and rhynchosaurs, because we are less sure of them than we were a dozen years ago. "The more recent general classifications of the reptiles by Cope, Osborn, Boulenger, and others have offered suggestions of value, but they are by no means the real solutions of the reptilian and amphibian phylogenies. The recent classifications of Jaekel are not to be taken seriously." Certain morphological problems are discussed in the following pages and the author has given what seem to be the legitimate conclusions regarding the immediate relationships of the forms under discussion. The present work, however, is offered more as a contribution to our knowledge of ancient reptiles and amphibians, with such summaries and definitions, based chiefly upon American forms, as our knowledge at hand permits. The illustrations of the work throughout were made by the author.

A summary of the genera from the Texas Permian follows: Amphibia: *Lysorophus, Diplocaulus, Trimerorhachis* (apparently absent from the upper part), *Eryops, Cacops, Dissorophus, Aspidosaurus, Cardiacephalus.* Reptilia: from the uppermost beds, *Labidosaurus, Naosaurus, Dimetrodon;* from lower horizons, *Naosaurus, Dimetrodon, Clepsydrops, Varanosaurus, Trispondylus, Casea, Aræoscelis, Captorhinus, Diadectes, Seymouria,* etc., of which perhaps the most characteristic are *Labidosaurus* of the upper and *Cricotus* of the lower zones. Williston feels confident, however, that no definite line can be made between the two divisions, and that at present Clear Fork can be used in a general way to designate the upper, and Wichita the lower part of the Texas deposits.

Most of the important specimens come from two isolated deposits known as the Cacops and Craddock bone beds, the former of which is among the most remarkable deposits of fossil vertebrates known, especially when one considers the almost universal rarity of Permian remains.

The Cacops deposit lies in the valley of the Wichita in northern Texas about five miles west of the Vernon road, not far from Indian Creek, while the Craddock bone bed lies about six miles northwest of Seymour, also in northern Texas. The Yale material, on the other hand, comes mainly from New Mexico, all of the Marsh types coming from a deposit which Williston has designated the Baldwin bone bed.

The research of Professors Williston and Case is one of great promise, not only in the ultimate clarifying of our vision with regard to the anatomy and relationships of these ancient forms, but in revealing to us the actual stages of transition between two great vertebrate classes, the Amphibia and Reptilia. For his present book Professor Williston deserves our gratitude, and we look forward confidently to still more notable results when his researches shall have been completed.

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Microbiology, for Agricultural and Domestic Science Students. By Marshall and others. Philadelphia, P. Blakiston's Son and Co.

In this work, of which Chas. E. Marshall is editor, there have been brought together and collated as one, a large number of separate articles upon various phases of bacteriology, mycology and protozoology. The plan of the editor has been to have the various phases of these extensive subjects written up by such persons among our American scientists as have made them specialties, and then to have them edited and collated so as to constitute a logical whole. The result has been to produce a very remarkable book. Other books upon bacteriology, because of the many phases of the subject, have the fault of being one-sided, since each author inevitably knows his own phase of the subject best, and not only writes this part best, but is almost sure to exaggerate its importance. If he has been especially interested in the pathological side, pathological bacteriology becomes too prominent, while if he has worked himself upon soils, soil bacteriology becomes over-emphasized. By the plan of Marshall this becomes impossible, since each author is expected to write upon his specialty alone and to give it all the emphasis he can in the space allotted to him. Any error in perspective can thus come only from an error in the space allotted to each subject. In the balancing of the various topics presented in the work excellent judgment is shown, though perhaps, considering its immense importance, comparatively too little space is devoted to pathological microbiology. The result is a book treating of a large variety of subjects and all written by specialists who know their subjects so thoroughly that they can speak with authority. Under these conditions not only are the subjects efficiently handled, but there is a minimum of error, since no part of the book is the product of one writing except on familiar ground.

On the other hand the plan has the disadvantage of showing considerable inequality in the skill of the treatment of its different parts. Twenty different authors can not be equally successful in the presentation of their subject, and no amount of editing can avoid discrepancies in the manner and skill of treatment. Another result has been to produce a book of a size almost unmanageable for its original purpose. Designed as a text-book for agricultural and domestic science students, it has become what might almost be called a collection of monographs. It is a book of 700 pages, of large size, small print, narrow spacing and with matter form condensed to the smallest possible number of words, and together forms a bulk of material practically hopeless to expect an ordinary college class to master. As a book of reference it is invaluable, but the substance is too great to expect it can be handled by any class. But recognizing these limitations, the book becomes a most extremely valuable addition to the literature of bacteriology, perhaps the most valuable single publication that has yet appeared. The various authors are particularly to be thanked for the time and care taken in what must at best be a work of love.

A better idea of the scope of the work may be obtained from the following condensed outline:

Part I. Morphology and culture of microorganisms, including molds (Thom), yeasts (Bioletti), bacteria (Dorset) and protozoa (Todd).

Part II. Physiology of microorganisms (Rahn).
- Nutrition and metabolism.
- Physical influences.
- Chemical influences.
- Mutual influences.

Part III. Applied microbiology, including microbiology of the air (Buchanan), of water (Harrison), sewage (Phelps), the soil (Lipman), of milk (Stocking), of butter and cheese (Hastings), of special dairy products (Stocking), of desiccation of foods (Buchanan), of preservation by heat (Edwards), by cold (MacNeal), by chemicals (MacNeal), food poisoning (MacNeal), alcoholic products (Bioletti), vinegar (Bioletti), other fermented products (Bioletti), vaccines (King), antisera and other products (King), diseases of plants (Sackett), methods and channels of infection in man and animals (McCampbell), immunity and susceptibility (McCampbell), microbial diseases of man and animals by various authors and control of infectious diseases (Hill).

This outline gives an idea of the comprehensiveness with which the subjects are covered; only an examination of the work itself can show the method of treatment and the completeness with which the many phases of the many-sided microbiology are treated.

The book is well printed, though the type is small and the pages look crowded. There are 128 figures in the book, of widely varying grades of merit. The editing is well done and the errors are few. Whether or not the book will prove useful in classes it will be indispensable for a bacteriologist's book shelves.

H. W. Conn

SPECIAL ARTICLES

STUDIES ON THE WILT DISEASE, OR "FLACHERIA" OF THE GYPSY MOTH

For the past six months we have been engaged in a study of the cause and nature of the wilt disease of gypsy moth caterpillars. The disease, so far as we are able to learn, is similar to the one attacking the nun moth (*Lymantria monacha* L.) in Germany. But although the investigations carried on in that country have led usually to negative results so far as the causative agent of the disease is concerned, still the work has been in the main of a scientific character. We are speaking of such work as has been done by Escherich, Prowazek and Tubeuf. This is more than can be said of some of the attempts made in this country and we thoroughly agree with Escherich,[1] who says, in speaking of a recent paper by Mr. William Reiff[2] "Es fehlt also so ziemlich alles, was zu einem wissenschaftlichen Beweis für die behaupteten Zusammenhänge gehört."

Our first attempts were confined to a search for protozoa in the tissues of the caterpillars, and while dissecting and examining these many were seen to contain certain polygonal bodies clustered around their tracheæ. These bodies have a very high refractive index and resist all stains, with the exception of iodine, in which they take on a uniform tint. No definite internal structure can be detected, however, and it finally dawned upon us that we had a case here analogous to the one in the nun moth. Bolle[3] first found these bodies in sick silkworms, and Tubeuf later discovered them in nun moth caterpillars afflicted with the "Wipfelkrankheit," a sickness the symptoms of which seem to be in many respects similar to those of the gypsy moth wilt. Wachtl and Kornauth[4] were the first to realize that the so-called polyhedral bodies have a diagnostic value, for caterpillars afflicted with "Wipfelkrankheit" are never free from them. Wolff[5] thinks that they are reaction-bodies having nothing to do with the cause of the disease. This he believes to be due to the presence of certain bodies called "Chlamydozoa" by Prowazek. Wolbach and McKee,[6] however, have since shown that the "Chlamydozoa" are products of mucous secretions under pathological conditions and not organisms. Escherich and Miyajima[7] resumed the study of the polyhedral bodies and besides presenting many original observations, confirmed Wachtl and Kornauth's results as to the high diagnostic value of these crystal-like aggregates. The figures and descriptions given by the former authors are very good, and we have no reason to doubt that the bodies which we find in the gypsy moth are precisely the same. At the beginning of the infection these polyhedral bodies are few in

[1] *Naturwiss. Zeitschr. für Forst und Landwirtschaft*, Heft 2 u. 3, Feb.–Marz, 1912, p. 85.

[2] "The Wilt Disease, or Flacherie of the Gypsy Moth," published by the Bussey Institution of Harvard University, 1911.

[3] "Der Seidenbau in Japan, nebst einem Anhang: Die Gelb-oder Fettsucht der Seidenraupe, eine parasitäre Krankheit," Budapest, Wien und Leipzig (Hartlebens Verlag), 1898.

[4] "Beiträge zur Kenntnis der Morphologie, Biologie und Pathologie der Nonne," *Mitteil. forstl. Versuchswesen Österreichs*, Heft XVI., Wien, 1893.

[5] "Uber eine neue Krankheit der Raupe von *Bupalus piniarius* L.," *Kaiser Wilhelm-Institutes für Landwirtschaft in Bromberg*, Band III., Heft 2, 1910, s. 69–92.

[6] "The Nature of Trachoma Bodies," *Journ. Med. Research*, n. s., Vol. XIX., No. 2, pp. 259–264, April, 1911.

[7] "Studien über die Wipfelkrankheit der Nonne," *Naturwiss. Zeitschr. für Forst und Landwirtschaft*, Heft 9, 1911, pp. 381–402.

numbers, but later they surround the tracheæ in curious cyst-like clusters. Still later the other cells become filled up with them and finally, when the caterpillar dies and disintegrates, they escape into the body fluids. The polyhedral bodies, to be sure, behave as crystals, but, not finding at the time anything of interest in the tissues, we gave them considerable attention, confirming Escherich's various chemical tests and staining reactions. That the polyhedral bodies might be organisms, perhaps distantly related to the microsporidians, seemed inconceivable; still their curious cyst-like arrangement around the tracheæ helped much towards concentrating our studies upon them. They revealed nothing, however, which could in any way be associated with parasitism and were finally abandoned as mere reaction-bodies, possibly urates. They react fairly well to the murexid test, giving all the color reactions except the last one. Why we have been unable to obtain this last reaction we are at present unable to say. We find that these bodies can be readily centrifuged out from sick and dead caterpillars and in quantities sufficient for purposes of chemical analysis, and we hope to be able to give a more intelligible account of them later. Nevertheless, as has always been supposed, the polyhedral bodies seem to have some significance, for after using good light and very high magnification small wriggling organisms were observed in the fat cells and other cells at such times as the polyhedral bodies were clustered around the tracheæ. These moving organisms were stained and found to be bacteria. From this time on we pursued the work along bacteriological lines and we believe have been able to demonstrate the etiological connection of these bacteria with the disease.

Living caterpillars are the only ones which can be treated with fixing fluids for sectioning. When a caterpillar dies of the wilt the degeneration of the tissues is so rapid that it is impossible to handle it. When touched, it goes all to pieces and therefore can never be used for histological work. Some of the sectioned material showed that hardly any of the tissues failed to reveal the presence of this bacterium. It was found in great numbers in all parts of the intestine and in many caterpillars appeared to be in the act of perforating its walls. The fat cells seem to be particularly liable to attack, which probably accounts for the saponified nature of the fat of sick caterpillars. The musculature, ganglia, testes, ovaries, œnocytes and other cells are also heavily parasitized. In fact, as previously stated, nothing seems to be exempt, since the infection extends even to the hypodermal cells. Some larvæ show a heavier degree of parasitism than others, while a certain number apparently not diseased may be free from the bacteria.

The organism in question is very small, having a diameter of only .51 μ–.85 μ. It resembles *Pneumococcus* very closely except that it is motile, progressing in a gyrating manner. For this reason, and because it seems to be an undescribed form, we have named it *Gyrococcus*. A brief technical description of it is given at the end of this paper.

Smears of dead larvæ were now studied and after making the smears very thin and using Grübler's Giemsa or Delafield's hæmatoxylin with eosin, the *Gyrococci* were more clearly revealed. Owing to their minuteness it is almost impossible to see them in thick smears. They are also apt to be obscured by the polyhedral bodies, which are very abundant in dead material, so that smears must be thinned out with sterile water in order to separate these bodies. Then only can the *Gyrococcus* be recognized easily under the 2 mm. oil immersion in combination with the compensating 12 or 18 ocular. In material which has been dead a long time many different species of septic bacteria accumulate, but caterpillars which have just died are fairly pure except for the *Gyrococci* which are present in large numbers.

In order that the non-pathogenic forms might give us as little trouble as possible, we inoculated sterile veal tubes with the fat of living infected material. These tubes were kept in an insectary where the temperature fluctuated during May, June and July between 80° and 95° Fahrenheit. We thought that such a temperature might be favorable for growth, because we found that a certain number of our caterpillars died from "flacherie" throughout the winter whenever we allowed the temperature to rise sufficiently in the insectary. Furthermore, our field experience later in the season clearly demonstrated to us that more caterpillars die of "flacherie" on a warm than on a cool day. In twenty-four hours the veal tubes became turbid. They were examined and *Gyrococcus* was found to be present in great numbers, together with a few other forms. These were then isolated on agar and after about forty-eight hours, small, round or oblong, smooth, cretaceous colonies were found, which showed again after microscopic examination that our bacterium grows on agar. Other sterile tubes were inoculated with these pure colonies and after twenty-four hours more a pure growth was obtained. These tubes remained odorless from the beginning of the growth to the time when the nutriment became exhausted. The first impure set of tubes had an odor due to the presence of septic forms.

For inoculation purposes, the fact that larvæ looked healthy externally was not considered to be sufficient evidence that they were free from infection, for a larva may appear reasonably healthy and feed normally with a greater or less number of germs in its system. As a matter of fact, if the temperature and food conditions are favorable a larva may pass through its sixth moult, pupate and even transform into a moth, carrying a number of *Gyrococci* along during the process. External conditions have a great influence on the rapidity with which the *Gyrococcus* multiplies within its host and for that matter within the veal tubes also. Hence, owing to the apparent feeble virulence which the *Gyrococcus* has when few in numbers, the external appearance of a larva means absolutely nothing. The blood, however, affords a very excellent diagnostic medium. The caterpillars were therefore tapped and only those were used in the experiments which were found to be free from the *Gyrococcus*. The blood was usually tapped from one of the prolegs. This operation can be repeated on the same larva at intervals of a day or two without injuring it. After tapping the blood each caterpillar was isolated in a separate, clean box and fed only with food which had been carefully selected and washed.

All the caterpillars which were pronounced free from infection after the blood had been carefully examined for *Gyrococcus* were divided into four lots. Each lot was used for an experiment with a pure culture of the bacterium. Twelve caterpillars were inoculated in the proleg and twelve in the dorsal vessel. Four controls accompanied each one of these lots. Twelve caterpillars were fed with the pure culture from a sterile pipette and fourteen were fed with leaves smeared with the culture.

The table given below comprises the results of one series of our experiments. The rate of death at each day succeeding the inoculation or the feeding is represented. Since at this time all of the caterpillars were full grown several of them pupated.

TABLE

The first and second days were very hot.
The third and fourth days were very cool.

Number of Days After Inoculation or Feeding	No. of Caterpillars which Died			
	Inoculation in Proleg	Inoculation in Dorsal Vessel	Fed from Pipette	Fed with Smeared Leaves
First day	3	3	3	6
Second day	2	2	4	2
Third day				
Fourth day				
Fifth day	1	1	3	2
Sixth day	2	1	1	
Seventh day		1	1	2
Eighth day				1
Ninth day		1		1
Tenth day	1			
Eleventh day	1	1		

It will be seen from the table that ten caterpillars out of the twelve inoculated in the proleg succumbed to the disease. Two out of the ten died in the pupal stage. Of the surviving two, one is still a pupa at the time of writing and one emerged. Ten out of the twelve inoculated in the dorsal vessel died, the remaining two are still pupæ. All of the deaths were typical of "flachérie." Of the two lots used for feeding experiments all died without a single exception. All of the controls survived and pupated, and some of these have already become moths.

It will be noticed that some caterpillars seemed to be more resistant than others or perhaps they may not have received as large a dose and consequently were longer in dying. The feeding experiments were particularly successful, all of the caterpillars succumbing within nine days with the typical symptoms of "flacherie." We performed several series of experiments similar to the ones outlined above and the results in general agreed very well with those of the described series. That the feeding experiments were more successful than the others may be accounted for in one of two ways. First, in feeding we evidently gave them a larger dose, for our inoculating needles are very fine indeed to avoid injury to the caterpillars and consequently the number of *Gyrococci* introduced by inoculation must be considerably less than the number introduced by feeding. Second, the infection naturally enters by way of the mouth with the food, for sectioned material shows that in some cases while none of the cells are as yet attacked, the proctenteron is nevertheless heavily infected. As soon as a caterpillar died it was carefully examined and those which died as a result of the two methods of feeding were found to be much more heavily infected than those which died after the inoculating experiments, although in the latter case the number of bacteria was great enough to have caused death.

Whenever any of the control experiments died, which did not often happen, we could always trace it to carelessness on our part, for careful reexamination of our original blood slide sufficed to show that the *Gyrococcus* had been present and had been overlooked. In nearly all cases we were successful in obtaining moths from our controls.

It was very interesting to see the influence which the temperature exerted on these experiments, for on hot days three times as many caterpillars died of the disease as on cool days. Two such cool days are represented in the table by the third and fourth dates, when not a single caterpillar died in any of the experiments. We do not mean to say that temperature is the only factor which is of importance, but its activating power is as striking in the laboratory and insectary as it is in the field. For this reason we believe caterpillars in their first, second and third instars usually escape not because they are small, but because when the caterpillars are still in these stages the weather is comparatively cool and the food is still plentiful even in heavily infested localities. Bad food or lack of food also bears an intimate relation to the period of life at which a caterpillar may die of the disease. Poor or insufficient food must obviously lower a caterpillar's vitality and weaken its powers of resistance.

In each series of inoculating experiments a few caterpillars survived and pupated. Some died with the disease during this stage, while a few transformed. When the latter were examined the body fluids and tissues of the moths were found to be full of *Gyrococci* and the ovaries were also infected, showing the great possibility for the transmission of the disease to the offspring through the eggs. In fact, there are two things which suggest that "flacherie" may be transmitted in this manner. First, caterpillars which are reared from eggs and kept isolated contract the disease independently of one another. Second, we have found the ovaries of material used for experimentation as well as some of the ovaries dissected from moths caught in the field to be infected. In the males, however, we have been unable thus far to find *Gyrococcus* either in the seminal fluids or in the spermatozoa. Hence we conclude that the transmission of the disease is probably accomplished through the eggs, although up to this time we have not had time to section any of these.

To exclude the possibility of having really inoculated an ultra visible virus together with the *Gyrococcus,* a large number of caterpillars were prepared (blood tested) for inoculation and feeding with material passed through the Berkefeld filter. Those fed and inoculated with the filtered culture all survived, while those which were treated in the same manner with the unfiltered culture all died.

It might be well to call attention to the fact that caterpillars fed with the juices of those which die of the disease succumb as rapidly as do caterpillars fed with the pure culture. The disease is probably spread in nature by the juices of disintegrated caterpillars flowing over the leaves which are later eaten by others. We have found *Gyrococcus* in the fæces, and the fact that such excretions are washed over the leaves by rain seems to show that the disease may also be spread in this manner.

What economic value the "flacherie" disease may have in combating the gypsy moth, we are not prepared at present to say. We have no experimental evidence whatsover that the disease may be air-borne, as claimed by Mr. Reiff, although, of course, we do not wish to exclude such a possibility. Our experiments seem to show, first, that it takes a good many *Gyrococci* to kill a caterpillar and, second, that conditions must be favorable for the disease or, putting it in another way, unfavorable to the caterpillars by lowering their vitality; so it seems very improbable that any such methods as are at present utilized for the artificial spread of "flacherie" will be of any avail.

The present race of gypsy moths in Massachusetts seems to be permeated with the disease, for we have been unable to find a single locality where "flacherie" is not accomplishing some good. Professor Wheeler has made many observations and he agrees with us as to the above statement. He has been out with us on many of our inspection trips and has likewise noticed the great influence which temperature and other external conditions seem to have on the disease. Since we can not control external conditions and since the disease accomplishes so much good in nature and is probably increasing year by year, and since it is transmitted from mother to offspring, we may have to content ourselves with its natural havoc.

In conclusion we append a description of the peculiar bacterium which we believe to be the specific cause of the wilt disease, with a discussion of its generic characters.

Gyrococcus flaccidifex gen. et sp. nov. Cells in free state spherical, becoming slightly oblong just before division. Division in one direction of space only. After division each half may be spherical or may come to an abrupt tip, assuming a more or less heart-shaped appearance. Frequently the two halves are unequal; one half may be spherical while the other may be more or less heart-shaped, or slightly oblong. If cells remain connected after fission, chains of three or four are formed. A chain exceeding four units has never been observed. Size of single cells; diameter .51 μ–.85 μ. No evidences of endospore formation. Capsule distinct. Organs of locomotion present. Gram-negative. Colonies on agar spherical or oblong, small (diam. .5–1 mm.), smooth, cretaceous.

All of the above size and form characters may vary somewhat, especially in *Gyrococci* under cultivation. They are somewhat larger after long culture on artificial media and the formation of chains of three or four is much more frequent. Indeed, the formation of chains has never been observed in the fluids or tissues of the host. We are certain that the *Gyrococci* are motile, for when all air currents are excluded from the slide with sterile vasaline and everything is quieted down as much as possible, they gyrate across the field of vision in all directions and with remarkable rapidity. Furthermore, their behavior in the living cells is such that no one would mistake their activities for Brownian movement. Flagellar stains were tried, but so far without success.

It will be seen from the above description that *Gyrococcus* resembles *Pneumococcus* more closely than any other form. Its motility and its negative reaction to Gram's stain are, however, sufficient, we believe, to exclude it from that genus and hence, owing to its peculiar gyrating mode of locomotion we have proposed for it the generic name of *Gyrococcus,* and owing to the striking flaccidity of caterpillars dying as a result of its presence, we have selected the specific name *flaccidifex.*

A much more detailed account of our work will be published later.

R. W. Glaser,
J. W. Chapman

Bussey Institution,
Forest Hills, Mass.,
July 22, 1912

THE PROLIFICNESS OF GAMBUSIA

On June 3, 1912, there was received at the aquarium of the Bureau of Fisheries in Washington a lot of top minnows (*Gambusia affinis*) from the lower Potomac River, comprising several males and about 90 females heavy with young. On June 7, the expulsion of the young began, and by June 27 all the females had become spent.

The viviparity, the relative scarcity of males, the great disparity in the size of the sexes and various other facts regarding this species are well known, although I have been able to find no adequate account of some of the most interesting phases of its life history. The principal object of this note is to call attention to the remarkable prolificacy of this little fish, which probably has few parallels among viviparous vertebrates.

The young are expelled in lots of 1 to 5 at short intervals, and the entire brood is delivered in the course of one and a half to three hours. The young swim readily and actively immediately after expulsion. Their length at birth is 8 to 9 mm. The progeny of one mother fish forms a very sizable school; and it was this that suggested the taking of an accurate family census. On one moribund fish 5 cm. long, that had apparently succumbed from inability to expel her young, a Cesarian operation was performed, and 33 living and 51 dead embryos were taken. Other fish 4.5 to 5 cm. long were killed, and counts of the fully developed young were made, the numbers ranging from 85 to 134, the average for all fish examined being exactly 100.

The production of two broods in a season has been suggested by the fact that young are born in spring and also in late summer. This may indicate only a protracted breeding season; but in the fish now under observation there are conspicuous ova which might easily reach full development in six to eight weeks, and fish from the same locality which I examined 22 years ago contained large embryos on August 11. If there are later broods, as I am now inclined to believe, this might account for the marked difference in the average number of young ascertained to be produced by fish observed in June, 1912, and by fish of same size and from same stream in August, 1890, the average for the former being 100 and for the latter 24 (the extremes being 18 and 30). Inasmuch as a second lot of ova would have to attain a certain degree of development while the abdomen was crowded with embryos, it might easily happen that fewer eggs would come to maturity and be fertilized than in the case of the first brood. This may afford a clue to the statement of the late Professor Ryder that "viviparous forms like the cyprinodonts have comparatively few ova, and the number may be as few as 15 or 20 in such a form as *Gambusia.*"[1]

An interesting observation is the cannibalistic tendency of the parent fish. Notwithstanding other food was present, the adults showed a pronounced fondness for their offspring, and began to feed on them soon after they were born. In order to save the young, it was necessary to retain the adults in a wire cage through the meshes of which the young could escape into the aquarium. One fish 4.8 cm. which was transferred to a special receptacle produced 85 living, healthy young, and devoured about half of them during the second night. Another fish that was under observation chased assiduously her first born as soon as it was expelled.

H. M. Smith

Washington, D. C.,
July 1, 1912

[1] Bull. U. S. Fish Comm., 1883, p. 196.

SCIENCE

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FRIDAY, AUGUST 23, 1912

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THE PHILOSOPHY OF A SCIENTIST[1]

IT may be asked what right has a scientist to have a philosophy? He spends his days in the study of gross, material things. The geologist busies himself with the earth, the composition and the structure of its crust, the nature of its rocks and other formations, the fossil remains of geologic ages, the elevation of its mountains, and the forces that tend to level the same. These and correlated subjects furnish the material with which his mentality employs itself and upon which it exhausts itself. The astronomer goes further afield and employs his time in the study of the moon, sun and the stars, but all his activities are materialistic. The biologist concerns himself with the development and modification of the various forms of life. His field is a wide and interesting one. The physicist is engaged in the observation of mass, and the effect of forces thereon. The chemist goes into the atomic structure and arrangement of matter. The physiologist is busy with function and the pathologist with abnormal structure and function. So we might go on enumerating the varied and multiple duties of the scientist, but, after all, his range of activity is confined to material things and what does he know of the higher life? What right has he to interest himself or to offer to speak with any authority on the great problems of life? What can the scientist know about idealism? Between materialism and idealism there is supposed to be a great chasm, which no man in his right senses would

[1] A popular lecture given in the summer school at the University of Michigan, July 2, 1912.

attempt to bridge. The scientist may be a silent follower of the idealist, but has no right to make even a suggestion, and to attempt to point out the way is the height of assumption on his part. The idealist is supposed to walk on a higher plane than the poor, materialistic scientist. The former dwells in the clouds. His food is the nectar of Olympus, and he spins his raiment from the philosophical theories evolved from his inner consciousness.

That I have not misstated the attitude of the modern idealistic philosopher toward modern science is shown by the following quotation from the work entitled "The Problem of Life," by Professor Eucken, of Jena. This book secured for its author the Nobel prize in 1908. In speaking of the theory of evolution Professor Eucken says:

> We are not concerned with the theory in its scientific aspect, but merely as it affects the attitude toward life. From this point of view it is of paramount importance to keep the two stages of the doctrine clearly distinct. It is mainly the theory of natural selection that has ventured to come forward with a new and original view of life. By completely assimilating man to nature, it leaves the shaping of man's life with the forces which appear to control the formation of natural types. Life is thereby robbed of all that had given it inner worth, and dignity; the form which it takes is determined solely by circumstance, and is maintained only in so far as it proves serviceable in the struggle for existence. Advance is only made when properties which chance has brought together are maintained on account of their usefulness, inherited, and in the course of time wrought into the species. But since there can be no inward appropriation of this gain, there can also be no joy in the good and beautiful for their own sake. All we win is simply an added means of self-preservation. We have already seen in Adam Smith the effect of a doctrine of mere utility in lowering the status of the inward life, and here we see it in its extreme form. The inward life loses all independent value. The only right is the right of the stronger; all humanness, in particular, all care for the weak and suffering would simply take the heart out of the struggle, and therefore be a piece of pernicious folly. If in this blind medley of conflicting forces there be anything at all left for us to do, it can only be to make the struggle for existence as hard, persistent and ruthless as we can, so that all the unfit may be weeded out, and the process of selection be made as speedy as possible.

This is the estimate placed upon the doctrine of evolution by one of the foremost of modern philosophers. Notice that he speaks of the scientist *venturing* to suggest something bearing on the problem of life. Rash and foolish scientist, what right has he to make a suggestion concerning the higher life? He should have known that the realm of philosophy is wholly beyond the domain of science, which concerns itself with only things material. The learned author objects to completely assimilating man with nature. This implies that he thinks man, in part at least, supernatural. If so, in what particular, may we inquire? If man is not shaped by the conditions under which he is born, his ancestry, and those under which he lives, his environment, pray tell what does shape him? Why the various races and varieties? If there be something supernatural in man, something that is not determined by natural conditions, why are there physical differences, intellectual inequalities and moral deviations among different peoples and among the same nations in successive generations? How many Pasteurs, Goethes or Shakespeares has the Ethiopian produced? This supernatural part of man in which the modern philosopher believes must be very capriciously distributed, and how is the distribution determined? Is blind chance the agent, or is the distribution made by some fickle God? Professor Eucken says that the assumption that types of men are determined by natural conditions robs life of all that gives it inner worth and dignity. Types of men exist. This can not be denied. If they do not result from natural causes, what are the supernatural agencies that bring them into existence? There are good and bad types of men, then there must be good and bad genii. The truth is, the philosophy of Professor Eucken is a mental remnant of the primitive man who believed in a geocentric universe, peopled Olympus with gods, good and bad, and filled the woods with satyrs, nymphs and fairies. If the learned author knew something of science he would be more of a philosopher. He speaks of the inner life losing all independent value if man is affected by external conditions. I infer from this that he makes the inner life the supernatural part of man. It is impossible to tell what he means by the inner life. If he means man's mentality, we know that this is affected by natural conditions. Strike a man on the head and depress his skull and his mentality is disturbed. Under the influence of such a poison as alcohol he may become insane. If by inner life he means man's morality, there again are abundant evidences that man's morality is affected by external conditions. The insane are not criminally responsible, and a man with some foreign body driven into his brain may become a liar, a thief or a murderer.

The condemnation of science by Professor Eucken for its cruelty can be explained only on the assumption that he fails utterly to comprehend the doctrine of evolution. Is the science of eugenics, whose object is to secure healthier and better parents for the unborn, cruel? Are all our efforts toward securing wholesome water, unadulterated food, hygienic housing, and, in short, the betterment of life in every possible way, cruel? Do we improve our breeds of horses, cows, dogs, etc., by turning them out without shelter in the most rigorous weather, and who proposes to improve the types of man in that way?

No philosophy evolved from the inner consciousness of man has ever done man half the good that has been secured to him by the discovery of the agents of infection. In fact no important discovery in science has failed to better the lot of man. The printing press disseminated knowledge. The discovery of illuminating gas drove crime from the streets of large cities. The telegraph and telephone have hastened the detection of the criminal. Steam and electricity are driving the wheels of the manufacturing world and distributing the products of all climes. Improved machinery is shortening the hours of labor and lifting from man's shoulders his heaviest burdens. In short, I know of no scientific discovery which has not contributed to the physical, intellectual and moral betterment of the world, and certainly this can be said of nothing else.

The foundation stone of my philosophy is the doctrine of evolution, the truth of which has been so abundantly and positively demonstrated by geological, embryological and biological evidence. I shall not attempt to establish the soundness of the theory of evolution. I consider this already done.

Through countless ages this development has been going on. The time was in the history of this planet when the conditions of temperature, moisture, etc., were such that life as we know it could not have existed. But this does not mean that life in some form did not exist. By life we mean that combination of matter and energy by which the former is endowed with the capability of growth and reproduction. Such a combination of matter and energy might have existed when the earth was a molten mass, without water upon its surface and without the present atmospheric envelope, but the life of that time, if there were any, was quite different from any form of life as we know it. All physiologists hold to the dictum: Omne vivum ex vivo, and some say: Omne vivum ab eternitate ex vivo. However this may be, the primordial forms of life have developed into the present forms. The simple in structure and function has become more complex in both these directions. The unicellular has evolved the multicellular. The undifferentiated protoplasm, under the stimulation and guidance of natural selection and environment, forces which we with all our studies only vaguely comprehend, has been differentiated into the tissues, systems and organs possessed by the world of life as it exists to-day. Soft tissues have protected themselves with cartilaginous and bony structures. From the invertebrate the vertebrate has developed. Organs especially devoted to digestion and assimilation have been evolved. Muscles for locomotion have come into existence. The vascular systems for the distribution of blood and lymph have been slowly and gradually elaborated, and every part of the complex and highly developed animal has been placed under the control and direction of the nervous system. The highest product of this wonderful and complicated development is man. Science has not only taught, but has demonstrated, all these things. Man, though far still from perfection, has reached a stage when he has become the most powerful and direct agent in evolution. He takes the grasses of the field, the flowers of the plains, the trees of the forest, the lower animals in their native states, and makes them almost anything he wishes. By breeding and selection, by altered and improved environment, and by modification and control of the conditions of life he is able to do these things. From prehistoric times he has been cultivating, developing and improving the grains which serve him and his dependent animals as foods. With the dog, horse and cow he has developed special breeds to suit not only his needs, but even his whims. He has filled his gardens with a profusion and variety of flowers such as unaided nature has never produced. His orchards furnish his table with luscious fruits, so attractive in appearance, so great in size and so delicious in flavor that one can hardly realize that they have come from the wild varieties. Natural selection has been largely replaced by human selection, and who shall say that this is not natural? But best of all is the fact that man is himself an animal, yes, all animal, and therefore capable of being improved by breeding, selection and improved environment. Were man, even in part, other than animal or supernatural, and not influenced by natural and controlable conditions, the hope of his improvement would not be so great. A supernatural force, if there be such, is one which man can not know, can not study, can not modify, and if such a force controls the destiny of the race, man's attempts to improve his kind must be futile. A philosophy founded upon such a belief leads nowhere, stimulates to no good deed, and is barren and dead from the start. On the other hand, the belief that man himself is the most potent factor in evolution should call out the best effort in every one interested in the welfare of his kind. If my work can make two blades of grass where only one has grown, can so improve the native grain, which barely returns the seed sown, that it will produce a hundredfold; can convert the diminutive, sour, wild apple into the large, mellow, delicious pippin; can convert the native, scraggy pony, barely subsisting on the sparse growth of his native range, into the high-bred, well-developed, spirited, intelligent horse; can change the thieving, slinking wolf that once followed the nomadic man in order to feed upon the sparse remnants of his scanty meal, into the noble, intelligent dog that has become man's companion; above all, if my work can aid ever so little in bettering the condition of my fellow man, either in the present or in future generations; if these things be true there is every incentive to do what I may in the accomplishment of these things. Who can say that the doctrine of the descent of man from the lower animals degrades him? On the contrary, it shows what man has done even with the slight enlightenment of the past, and it points to the heights to which he may reasonably hope to climb in the future.

I believe in heredity, that like breeds like, and the good or bad in the parent will pass on to the child. This belief in heredity does not lead me to spend my time in studying ancestral records. No, I let the past take care of itself. It is gone and can not be changed. I like to think that all my good impulses come from my ancestors, and that my bad ones are due to acquired sins. But for the great lesson taught by our knowledge of heredity we should look to the future. Generations to come may make inquiry as to their ancestors, and then they may mean you or me. The young man of to-day who gives himself to drink and venery is preparing himself to be the father of degenerates, imbeciles and insane. That degeneracy is inherited there can be no doubt. Statistics collected in widely separated parts of the world show this to be true. Fortunately, good qualities are equally inheritable. Could there be a higher incentive to any one to keep himself clean physically and morally than this? If so, I have failed to hear of it. Science teaches us that our actions and even our words are parts of the environment in which those about us live and may influence them for good or ill, and may live through their effects upon others, and through them on generations yet unborn. Yea, more, our thoughts, even though unspoken, have their part in shaping ourselves. They constitute a part and an important part of our environment. Was there ever a higher incentive to righteousness in deed and purity in mind than this? Whether I shall do a certain thing or not should not be determined by hope of future reward or by fear of future punishment, but by its effects. Some of the most atrocious deeds recorded in history have been performed under the belief that religion and God were being thereby served. Such were the tortures of the Inquisition.

The doctrine of evolution teaches that environment is a powerful factor in the modification and improvement of species, and experiments upon plants and animals have confirmed these teachings so repeatedly and so positively that no sane man can question it. My philosophy, therefore, points out a way in which I can render a real and lasting service. I will therefore give my best endeavor to improve the conditions under which men live. This should be one of the strongest motives in the work of the scientist. Indeed, it should actuate the deeds of all intelligent men and women. The old Latin proverb: "Salus populi suprema lex est," which I should translate: "The welfare of the people should be our highest concern," is a good motto under which we should live and labor.

Ignorance is bad environment and therefore we should labor to dispel it. Ignorance should be replaced by knowledge, and this shall make us free and strong. That knowledge which we can use is the best. As one of England's historians has said:

> The knowledge which we can use is the only real knowledge; all else hangs like dust about the brain or dries up like rain drops off the stones.

The scientist, even though he be a rank materialist without any belief in the supernatural, with no thought of any personal existence beyond the grave, has his dreams of the future. He dreams of the time when the engines of destruction will be so powerful and certain in action that war will be impossible, and the world shall become one great community of enlightened, intelligent human beings, dwelling in peace and unity. He is striving not to send souls to heaven, but to convert earth into heaven. He dreams of a time when agriculture shall have been so perfected that the harvests shall supply of fruits and grains, such as the world has not yet seen, an abundance for all. He dreams of a time when there shall be no suffering or want, when every man shall labor and every man shall possess in equal abundance. He dreams of a time when there shall be no premature death, when sickness and pain have been abolished through the wisdom of man. He dreams of these things, not with the hope that he individually may participate in them, but with the joy that he may aid in their coming to those who shall live after him. It is more blessed to sow than to reap.

Science teaches, more effectually than any religion has ever done, the necessity of lending a helping hand to those in distress. The spread of infection has been a powerful agent in demonstrating to man that the condition of his less fortunate fellow is a matter of real concern to himself. Disease in the slums may spread to the palatial residences, and has shown the owner of the latter that the dweller in the former is indeed his neighbor. The typhoid bacillus finds its way from the squalid hut up the river into the great city, and visits the rich as well as the poor. Infection is an intruder against which locks and bolts furnish but slight protection. It comes in water, in milk, in food, in dust. It is brought by mosquito, fly or other insect. We meet infection in the street, we brush against it in the street car, and we sleep in it in the Pullman. It comes to our places of business, sits by us in the restaurant, or hotel, and travels with us by both rail and water. It demonstrates the close relationship of all classes and conditions of men, and proves that no man can live to himself alone. It compels the intelligent to instruct the ignorant, and the rich to help the poor. Our knowledge of the spread of infection is the strongest factor in the socialistic movement of the day.

There is another lesson which the well-to-do should learn from science. The man who employs labor should know that the efficiency of the laborer depends upon the conditions under which he lives. His wages should be sufficient to provide for himself and those dependent upon him enough wholesome food to eat, proper housing, proper clothing, means of education for his children and some rational recreation. Many of the captains of industry have amassed great fortunes by giving to their employees a minimum wage, compelling them to live in squalor and on a starvation diet. Some of these capitalists have distributed large sums thus secured in charities, and have hoped by these gifts to be known as great philanthropists. The time is fast coming when wealth thus accumulated will be regarded as unjustly secured. It is better to pay a living wage to every workmau than to distribute money obtained through the necessities of the poor in charity. Were justice more evenly and honestly practised by employers in the business world there would be less need of charity. I feel very strongly on this point. No man would think of running a costly machine or expect to get the highest efficiency out of it except under the most favorable conditions. He knows that low-grade fuel results in low-grade work, and he recognizes the fact that proper lubrication is essential. He knows these things and employs his knowledge in working his engines, and he too often apparently forgets that the human body is a machine, the most complicated, and under favorable conditions the most efficient one in the world.

I believe in the ascent of man from lower forms of animal life, and we need not look back very far to see the low level from which he has climbed. Indeed we need not look back at all. The mass of mankind even in the civilized world is diseased, ignorant and immoral. We say that this is an enlightened age, and that we live in a civilized land, all of which is true, but enlightenment and civilization are relative terms and cover widely different conditions. Physical health has been improved in the past century. Epidemics have been held in abeyance by scientific agencies. The average life has been prolonged, and the material conditions of life have been greatly advanced. Learning is gradually extending its boundaries, and productive scholarship is reaping rich harvests, to the great benefit of the race. Scholasticism no longer dominates our educational institutions, and research is busy clearing away the jungles and draining the swamps of ignorance and superstition. Man is appreciating his moral obligations more fully than he has ever done in the past. All these things are true, but disease still takes a heavy toll; ignorance still opposes advance, and moral tyrannies are still practised. When we look down into the depths from which man has climbed, even since historical records began, and where many of our kind still linger, we shudder, but when we look up to the heights to which he may still go we are filled with hope and joy. Then when we realize that each one may contribute to the progress of the race, the problem of life impresses upon us a hopeful seriousness, and a buoyant determination that though the task be great it is one well worth the effort.

Men are mortal, but man is immortal. The individual has only an ephemeral existence, but the germinal cell continues through all generations. The somatic man constitutes the temporary environment of the germ cell, and it is fortunate that the former has only a slight influence on the latter, but it is this slight influence which, multiplied though many generations, becomes the great and central moving force of evolution. This individual influence on the race is not confined to the direct line, but a man through his words and deeds may give direction to the growth of his neighbor, and on those to come from that neighbor. With this understanding, life is ennobled and impregnated with a divinity of which no religion has dreamed. It shows the brotherhood and interdependence of all men. It makes of the individual a unit, and an important factor in the great drama of creation. It makes the individual conscious of his duties and arms him with the means to perform them. It gives to the individual worth and dignity far beyond that conferred upon him by those philosophies the central doctrine of which is the hope of future reward, or the fear of future punishment. It is a practical, working philosophy which, when thoroughly understood and practised, will bring peace, good will, and brotherly love to all peoples of the earth. It does not lead to an imaginary heaven with streets paved with gold and precious stones, but it will bring to the earth and all that dwell therein a life of joy and righteousness.

The philosophy of science concerns itself with this world and with this life. It reaches every condition of life. It should pervade all our notions and influence all our actions. It should determine our rules of conduct. It should stimulate the individual in making the most possible out of himself. It teaches the necessity of keeping the body in the most perfect condition, and that a sound mind is found only in a sound body, because the former is only a product of the latter. Much has been said about the influence of mind on matter, while science demonstrates the influence of matter on mind, because the two are one and indivisible. The individual who abuses his body commits a sin not only against himself, but against the race of which he is an individual unit. The man who takes a material advantage over a fellow debases himself and sins against his kind. A government which fails to secure for its humblest citizens proper and sufficient food, sanitary shelter and means for intellectual growth can not properly claim to be for the benefit of the people, nor for the advancement of the race. The failure of our own government to do equal justice to all has given rise to the present widespread discontent. Law and justice are by no means synonymous. The time will come when the unlimited inheritance of property, like that of the inheritance of power, will be regarded as a relic of ignorance and barbarism. The acquisition of valuable, natural resources such as mineral deposits and forests by individuals and corporations should no longer be permitted, and those thus held should be subject to government control. No man accumulates great wealth by his own unaided effort. One buys a large tract of land which becomes highly valuable by the extension of a city, another is able to utilize a scientific discovery, in some industry, while a third finds opportunity to employ new machinery and by these and similar means great wealth is accumulated. This is not only legitimate, but when properly done is praiseworthy. The man who adds to the world's wealth makes life less burdensome, improves the facilities of transportation, adds to commerce, opens up new and profitable industries, increases the wages of labor and does these things without oppressing those who serve him is a benefactor to his race. The time will come when great captains of industry will be counted among the heroes of the nation, but the unlimited inheritance of wealth will not be permitted. Men will build fortunes which will not be employed to debauch their children, but will go to improve the conditions of life among the people as a whole. Intelligent men among those who have amassed great fortunes are already seeing this matter in its proper light. Mr. Carnegie has announced his desire to wisely distribute his property before his death, and the late Dr. Pearsons succeeded in distributing his millions and dying poor.

The conditions of life are compelling men to be brothers and ultimately they must largely stifle out of existence the gross forms of selfishness which still are so plainly evident. The urban resident must depend upon the city for his water supply and even the courts, so slow to progress, are beginning to recognize that the citizen has a just cause for action against the city if he or a member of his family becomes infected through the water supply. The dedependence of the individual upon the community and the duty of the community to the individual are being realized now as never in the past. The relation between ignorance, poverty and squalor on the one hand and knowledge, efficiency and proper living on the other is so plainly seen that it can no longer be disregarded by those who control our governmental affairs, both general and local. The morbidity and mortality rates in the slums of some of our great cities should shame us, and since disease is always spreading from these breeding places, a selfish motive, if there be no better impulse to direct, will force municipalities to tax the rich in order to better the condition of the poor.

Man's most distinguished virtues have grown out of his worst vices. At first the strong protected himself, his dependents and his property by brute force. As his intelligence developed he secured this protection by the enactment and enforcement of law, but now this fails and he is being driven by necessity to practise humanity toward his less favored friend. The material betterment of all classes and conditions of men is demanded by the philosophy of science, and it must and will come, if not through the agency of a wise evolution, it will be reached by more costly and less humane methods.

It will be seen that my philosophy is thoroughly materialistic. I believe that man has been evolved from lower forms of animal life, that he has advanced, slowly and laboriously, with many atavistic lapses, from the brute to a condition of comparative civilization, that he will continue along this road which he has traveled through countless generations, and that this will ultimately lead the race over the mountain tops and into the promised land of human perfection. I look for this not for the individual, but for the race, of which each is a small, but an important part. I conceive the highest duty of the individual to contribute his mite to the betterment of the whole. Science teaches that what the man thinks, says and does lives after him, and influences for good or ill future generations. To me this is a higher, nobler and greater incentive to righteousness than any hope of personal reward or fear of punishment in a future life. I believe that this is a glorious world, full of great opportunities to the individual, and of unlimited promise of development in the race. Life carries in itself the highest duties, the performance of which should not be regarded as tasks to be shirked if possible, or to be done reluctantly, but to be carried on with a spirit of thankfulness that it has fallen to the lot of the individual to be a participant in the great and glorious work of contributing to the uplift of the race. To widen the domain of knowledge, be it ever so little, to abate disease, to lessen pain and suffering, to decrease the burden of poverty, to brighten and ennoble the lives of others, to harness the forces of nature and make them subservient to man's will and contributory to his happiness, to increase the productiveness of the soil, to make man more considerate of his fellow, to appreciate and perform his duties, these are some of the things that science has done and is doing. To be even an humble and unknown worker in the great army of men who are doing these things is a privilege which should make glad the heart of any man.

Victor C. Vaughan

THE TRANSCONTINENTAL EXCURSION OF THE AMERICAN GEOGRAPHICAL SOCIETY OF NEW YORK

To celebrate the sixtieth anniversary of its founding, and the occupation of the new building which has been presented to it, the American Geographical Society of New York has planned, as has already been mentioned in Science, a transcontinental excursion, which is to be conducted by Professor William Morris Davis, of Harvard University. The excursion started from New York on August 22, and will end at New York on October 17 and 18, 1912. Many of the geographical societies of Europe were invited to appoint delegates to take part in the excursion. The following have accepted:

Austria

Dr. Eduard Brückner, professor of geography at the University of Vienna.

Dr. Fritz Machatschek, privatdozent of geography at the University of Vienna; editor of the Mitteilungen of the I. and R. Geographical Society of Vienna.

Dr. Eugen Oberhummer, professor of geography at the University of Vienna; president of the Geographical Society of Vienna.

Belgium

Jules Leclerq, former president of the Royal Belgian Geographical Society.

Paul Elsen, member of the Royal Geographical Society of Antwerp.

Denmark

Professor Ole Olufsen, secretary of the Royal Danish Geographical Society.

France

Henri Baulig, instructor in geography, University of Paris.

Albert Demangeon, professor of geography, University of Lille.

Emmanuel de Margerie, late president, Geological Society of France; associate editor, *Annales de Géographie.*

Edouard-Alfred Martel, Geological Survey of France; editor of *La Nature.*

Emmanuel de Martonne, professor of geography in the Universities of Lyons and Paris; associate editor of the *Annales de Géographie.*

Lucien Gallois, professor of geography, University of Paris; associate editor, *Annales de Géographie.*

Antoine Vacher, professor of geography, University of Lille.

Germany

Dr. Erich von Drygalski, professor of geography, University of Munich.

Dr. Fritz Jaeger, professor of colonial geography, University of Berlin.

Dr. Gottfried Merzbacher, explorer, München.

Dr. Joseph Partsch, professor of geography, University of Leipzig.

Dr. Alfred Rühl, Oceanographical Institute, Berlin.

Dr. Carl Uhlig, professor of geography, University of Tübingen.

Dr. Wilhelm Volz, instructor in geography, University of Breslau.

Great Britain

Henry O. Beckit, School of Geography, University of Oxford.

George G. Chisholm, lecturer on geography, University of Edinburgh; secretary to the Royal Scottish Geographical Society.

Alan Grant Ogilvie, School of Geography, University of Oxford.

Wm. H. Myles, Dunbar, Scotland.

Hungary

Dr. Eugene de Cholnoky, professor of geography, University of Kolozsvâr.

Count Paul Teleki, secretary of the Hungarian Geographical Society, Budapest.

Italy

Dr. Olinto Marinelli, professor of geography at the Institute of Higher Studies, Florence; co-editor of the *Rivista Geografica Italiana.*

Professor G. Ricchieri, Milan.

The Netherlands

J. F. Niermeyer, professor of economic geography, University of Utrecht; editor of the Journal of the Royal Geographical Society of the Netherlands.

Dr. Karl Oestreich, professor of physical geography, University of Utrecht.

Norway

Werner Werenskiold, lecturer on physical geography, University of Christiania.

Portugal

Dr. Francisco Silva Telles, professor of geography in the Faculty of Letters, University of Lisbon.

Russia

Wladimir Doubiansky, Imperial Botanical Gardens, St. Petersburg.

Jules M. Schokalsky, professor of physical geography at the Académie Navale Nicolas and at the École Supérieure Pédagogique.

Spain

Dr. Ricardo Beltrân y Rózpide, secretary of the Royal Geographical Society, Madrid; professor of geography at the School of Higher Studies for the Professorate.

Sweden

Dr. Gunnar Andersson, professor of economic geography at the College of Commerce, University of Stockholm; secretary of the Swedish Anthropological and Geographical Society; editor of *Ymer.*

SWITZERLAND

Emile Chaix, professor of economical and political geography, University of Geneva.

Dr. Fritz Nussbaum, instructor in geography, University of Bern; secretary of the Geographical Society of Bern.

INVESTIGATORS AT THE MARINE BIOLOGICAL LABORATORY

The investigators working at the Marine Biological Laboratory, Woods Hole, during the present season are:

Adkins, Walter S., graduate student, Columbia University.

Allyn, Harriet M., instructor in zoology, Vassar College.

Baitsell, George A., assistant in zoology, Yale University.

Bancroft, Frank N., associate, Rockefeller Institute.

Bartholemew, Elbert T., instructor in botany, University of Wisconsin.

Beckwith, Cora J., instructor in zoology, Vassar College.

Binford, Raymond, fellow in zoology, Johns Hopkins University.

Boring, Alice M., assistant professor of zoology, University of Maine.

Bradley, Harold C., assistant professor of physiological chemistry, University of Wisconsin.

Browne, Ethel N., graduate student, Columbia University.

Budington, R. A., associate professor of zoology, Oberlin College.

Calkins, Gary N., professor of protozoology, Columbia University.

Carver, Gail C., professor of biology, Mercer University, Macon, Ga.

Cary, Lewis R., instructor in zoology, Princeton University.

Chambers, Robert, associate professor of embryology and histology, University of Cincinnati.

Clapp, Cornelia M., professor of zoology, Mount Holyoke College.

Clark, Eleanor Linton, special student, Johns Hopkins University.

Clark, Eliot R., associate in anatomy, Johns Hopkins University.

Conklin, E. G., professor of biology, Princeton University.

Derick, Carrie M., professor of morphological botany, McGill University.

Donaldson, H. H., professor of neurology, Wistar Institute of Anatomy and Biology, Philadelphia.

Drew, Gilman A., assistant director, Marine Biological Laboratory.

Duggar, B. A., professor of plant physiology, Missouri Botanical Gardens, St. Louis, Mo.

Dungar, Neil S., acting professor of biology, Carleton College.

Edwards, Dayton J., tutor in physiology, College of the City of New York.

Ewald, W. F., fellow, Rockefeller Institute.

Flanigen, Ruth, graduate student, Columbia University.

Fromme, Fred D., assistant in botany, Columbia University.

Garrey, Walter E., associate professor of physiology, Washington University Medical College.

Goodrich, H. B., assistant in zoology, Columbia University.

Grave, Caswell, associate professor of zoology, Johns Hopkins University.

Gregory, Louise H., instructor in zoology, Barnard College.

Harper, R. A., professor of botany, Columbia University.

Hayden, Margaret A., teacher of biology, Western High School, Baltimore, Md.

Heilbrun, Lewis V., graduate student, Columbia University.

Hewitt, Joseph H., 2145 N. Halsted Street, Chicago, Ill.

Hickernell, Louis M., fellow, Princeton University.

Hoge, Mildred A., graduate student, Columbia University.

Hogue, Mary J., instructor in zoology, Mount Holyoke College.

Howe, Caroline C., teacher of biology, East Side High School, Newark, N. J.

Howland, Ruth B., associate professor of biology, Sweet Briar College.

Just, Ernest E., associate professor of biology, Howard University.

Kellersberger, Eugene R., graduate student, Washington University Medical School.

Kellicott, William E., professor of biology, Goucher College.

Kite, George L., fellow in pathology, Sprague Institute.

Knower, H. McE., professor of anatomy, University of Cincinnati.

Knowlton, Frank P., professor of physiology, Syracuse University.

Lewis, Ivey F., professor of biology, Randolph-Macon College.

Lewis, Margaret Reed, 1931 East 31st Street, Baltimore, Md.

Lewis, Warren H., associate professor of anatomy, Johns Hopkins University.

Lillie, Frank R., professor of embryology, University of Chicago, and director, Marine Biological Laboratory.

Lillie, Ralph S., assistant professor of experimental biology, University of Pennsylvania.

Loeb, Jacques, Rockefeller Institute.

Loeb, Leo, director, department of pathology, Barnard Free Skin and Cancer Hospital, St. Louis, Mo.

Lund, Elmer J., Bruce fellow, Johns Hopkins University.

Lyman, George R., assistant professor of botany, Dartmouth College.

Lyon, E. P., professor of physiology, St. Louis University.

Malone, Edward F., assistant professor of anatomy, University of Cincinnati.

Marquette, William G., Columbia University.

McCann, William S., graduate student, Cornell Medical College.

Meigs, Edward B., fellow in physiology, Wistar Institute of Anatomy and Biology.

Moore, George T., director, Missouri Botanical Gardens, St. Louis, Mo.

Morgan, T. H., professor of experimental zoology, Columbia University.

Morrill, Charles V., instructor in anatomy, University and Bellevue Hospital Medical College.

Morris, Margaret, 53 Edgehill Road, New Haven, Conn.

Nowlin, Nadine, instructor in zoology, University of Kansas.

Orcutt, Alfred W., fellow, University of Illinois.

Osterhout, W. J. V., assistant professor of botany, Harvard University.

Packard, Charles, assistant in zoology, Columbia University.

Pappenheimer, Alwin M., associate in pathology, Columbia University.

Patten, Hazel, laboratory assistant, Western High School, Baltimore, Md.

Patterson, J. T., adjunct professor of zoology, University of Texas.

Pearse, A. S., assistant professor of zoology, University of Wisconsin.

Robbins, William J., assistant in plant physiology, Cornell University.

Rosenow, Edward C., assistant professor of medicine, Rush Medical College.

Sink, Emory W., assistant in zoology, University of Michigan.

Smith, Bertram G., assistant professor of zoology, State Normal College, Ypsilanti, Mich.

Spaulding, E. G., assistant professor of philosophy, Princeton University.

Spencer, Henry J., graduate student, Columbia University.

Stockard, Charles R., professor of anatomy, Cornell Medical College.

Strong, Oliver S., instructor in anatomy, Columbia University.

Wallace, Edith M., research assistant, Columbia University.

Wasteneys, Hardolph, associate, Rockefeller Institute.

Wheeler, Isabel, graduate student, Columbia University.

Wherry, William B., professor of bacteriology, Cincinnati Hospital.

Wieman, H. L., assistant professor of zoology, University of Cincinnati.

Williams, Leonard W., instructor, Harvard Medical College.

Wilson, E. B., professor of zoology, Columbia University.

Woodruff, L. L., assistant professor of biology, Yale University.

THE UNITED STATES PUBLIC HEALTH SERVICE

The agitation which has been going on for the past few years for the enlargement of the health activities of the United States government has resulted in the passage of a law, signed by the president on August 14, which enlarges the functions of the Public Health and Marine-Hospital Service and changes the name to the "United States Public Health Service." Under this law the new Public Health Service is given very wide authority to investigate the "diseases of man and conditions influencing the propagation and spread thereof including sanitation," etc. All of the previous laws relating to quarantine, the eradication of certain epidemic diseases and the scientific investigations of the Hygienic Laboratory in bacteriology, pharmacology, chemistry, medical zoology, etc., remain in force so that now the United States has a national public health service with greater scope than that of any of the other leading nations.

SCIENTIFIC NOTES AND NEWS

In connection with the visit to Dundee in the beginning of September of the British Association for the Advancement of Science, the senate of the University of St. Andrews has resolved to confer the degree of LL.D. on sixteen foreign men of science who are expected to attend the meetings of the association. As a recognition of the president of the association, Professor E. A. Schaefer, of Edinburgh University, they are largely physiologists. The United States is represented by Dr. S. J. Meltzer, of the Rockefeller Institute of Medical Research.

Dr. Karl Schwarzschild, director of the astrophysical observatory near Potsdam, has been elected a member of the Berlin Academy of Sciences.

The Bavarian Academy of Sciences has conferred the medal "Bene merenti" on Dr. Karl Hoseus for his botanical collections from Siam.

Dr. J. G. Schurman, president of Cornell University, has been appointed minister to Greece, where he will spend a sabbatical year of leave of absence.

Professor Greenfield, of the University of Edinburgh, has been granted permission to retire, on a retiring allowance, from the chair of pathology.

Mr. J. C. Umney has been elected to preside over the jubilee meeting of the British Pharmaceutical Congress which will be held in London next year.

Dr. Langdon C. Stewardson has resigned the presidency of Hobart College.

Major W. W. Crosby has resigned as chief engineer of the state roads commission of Maryland to engage in practise as consulting engineer.

Dr. W. J. Holland, the director of the Carnegie Museum, accompanied by Mr. Arthur S. Coggeshall, the chief preparator in the section of paleontology of that museum, sailed for Buenos Aires on August 20 by the S.S. *Vasari* of the Lamport and Holt Line. Their errand is to install in the National Museum at La Plata a replica of *Diplodocus carnegiei* presented by Mr. Carnegie to the president of the Argentine Republic.

Dr. Raymond Pearl has returned from a brief visit to London, undertaken for the purpose of attending the first International Eugenics Congress and also a meeting of a provisional committee for the organization of an International Association of Poultry Instructors and Investigators. This association was formed, with representatives of twenty-seven countries in attendance. Mr. Edward Brown, F.L.S., of London, was chosen as the first president and Dr. Pearl as secretary.

Dr. A. F. Blakeslee has a year's leave of absence from the Connecticut Agricultural College. He has a temporary appointment on the staff of the Carnegie Station for Experimental Evolution at Cold Spring Harbor, L. I., N. Y., where he will spend the year in research work on the lower fungi.

Mr. Charles H. T. Townsend, who has been in Piura, Peru, for the past two years, removed with his family to Lima in June, 1912, to take charge of the Estación de Entomología, which will comprise all government entomological work in Peru and whose headquarters will be located at the capital. Mr. E. W. Rust remains in Piura in charge of the work there against cotton plagues, which will constitute a branch station. Mr. Rust was unharmed by the severe earthquake which occurred at Piura on the morning of July 24, 1912. All the collections, notes, books and manuscripts, and the more important part of the equipment of Mr. Townsend's office were removed to Lima with him, and thus escaped the effects of the earthquake.

Mr. Paul Korchoof, agricultural expert, department of the Russian ministry of agriculture, and Mr. Vaseelie Yurieff, assistant director, Kharkow Central Agricultural Experiment Station, have been visiting the agricultural colleges and stations of this country.

Professor W. A. Bone, F.R.S., will lecture before the German Chemical Society on November 30 on "Surface Combustion."

The following appointments to lectureships have been made by the Royal College of Physicians of London: Goulstonian lectures, Dr. A. J. Jex-Blake; Oliver Sharpey lectures, Dr. A. D. Waller, F.R.S.; Lumleian lectures, Dr. F. de Havilland Hall; Croonian lectures, Professor C. S. Sherrington, F.R.S., and FitzPatrick lectures, Dr. C. A. Mercier.

Dr. T. B. McClintic, of the United States Public Health Service, died in Washington on August 13 of Rocky Mountain spotted fever, contracted while investigating the disease in Montana. Dr. McClintic had done important work in the investigation and suppression of this fatal disease and in other directions. He was thirty-nine years of age and had been connected with the U. S. Public Health and Marine Hospital Service for fifteen years. He was a native of Virginia and a graduate of the University of Virginia.

Dr. Melville Amasa Scovell, director of the Kentucky Agricultural Experiment Station and dean of the College of Agriculture of the Kentucky State University, died at his residence, near Lexington, on August 15, after an illness of two weeks. By his distinguished services as an educator, chemist, agriculturist and authority on all matters pertaining to dairying and live stock, and as a broad-minded, public spirited citizen, Dr. Scovell made a deep impress on the affairs of the state and nation.

Professor John Craig, head of the department of horticulture of the New York State College of Agriculture, Cornell University, known for his contributions to pomology and agricultural education, died at Siasconset, Mass., on August 12. He was born at Lakefield, Canada, in 1864.

Professor John Alsop Paine, state botanist of New York in the early sixties, professor of natural sciences in Roberts College, Constantinople, and later curator in the Metropolitan Museum of Art, New York City, has died at the age of seventy-two years.

Mr. Allan Octavian Hume, known as an author on Indian ornithology, the donor of some seventy-five thousand skins and eggs of Indian birds to the British Museum, died on July 31, aged eighty-three years.

Mr. Harold Donaldson, of the British National Physical Laboratory, the author of researches on fused silica standards was drowned while bathing on July 29, at the age of twenty-five years.

Among the contributions recently made to the fund for the acquisition of new premises for the Royal Geographical Society, London, are a donation of £1,000 from the Argentine government, and the promise of £1,000, which is to be placed upon the estimates by the government of the Australian commonwealth.

The ninth International Otological Congress opened its sessions at the Harvard Medical School on August 12. Professor Körnel von Lichtenberg opened the congress and Dr. E. H. Bradford, dean of the Harvard Medical School, delivered the address of welcome. Professor Adam Politzer, Vittorio Grazzi, Urban Pritchard and E. J. Moure, honorary presidents, made short responses.

The first Mexican Scientific Congress will be held in the City of Mexico on December 9 to 14. The congress is organized by the scientific society Antonio Alzate, and is under the auspices of the minister of public instruction. The congress will meet in eight sections as follows: (1) philosophy, (2) sociology, (3) linguistics and philology, (4) mathematical sciences, (5) physical sciences, (6) natural sciences, (7) applied sciences, (8) geography, history and archeology.

Notice has been received at the Canadian Geological Survey of the fifth shipment of specimens from British Columbia for the Natural Museum of Ottawa, made during the past twelve months as a result of orders issued by Sir William Mackenzie on behalf of the Canadian Northern Railway. The specimens were found a short distance from Kamloops, B. C., and consist of bones ploughed up in a burrough pit in the side of the river. There are also some objects made of beaten copper and of bone and deer skin.

UNIVERSITY AND EDUCATIONAL NEWS

Mr. Julius Rosenwald, of Chicago, celebrated his fiftieth birthday by gifts of $687,500 for charitable and educational purposes, including $250,000 to the University of Chicago.

The estate of the late Dr. J. E. Robinson, first governor of Kansas, which by his will was left to the University of Kansas on the death of his wife, has become available. The value of the estate is in the neighborhood of $100,000. It is to be used for the medical school.

By the will of Mr. James Hall, the University of Manchester will ultimately receive at least £40,000 for the endowment of chairs of chemistry and philosophy and scholarships in these subjects.

New science laboratories at Cranleigh School, Surrey, the gift of Sir C. Chadwyck-Healey, were recently opened by Sir William Ramsay.

The Saxon government has decided against the project for a university at Dresden on the ground that the learned professions are already overcrowded and that the government does not regard the maintenance of two universities of the first grade as practicable.

Mr. Archibald A. Bowman, M.A., lecturer in logic at Glasgow University, has been appointed professor of philosophy in Princeton University to fill the vacancy caused by Professor J. G. Hibben's election to the presidency.

Professor W. J. Wright, formerly of the department of horticulture of the Pennsylvania State College, has resigned to accept the directorship of the New York State School of Agriculture at Alfred University, Alfred, New York.

The board of trustees of the University of Illinois, at a recent meeting, authorized three new professorships in the College of Agriculture. These are as follows: A professorship in landscape art, a professorship in animal pathology, and a professorship in dairy husbandry. The appointment of an associate and an instructor in landscape art and an assistant professor of genetics was also authorized. Last year a department of forestry was created but the chair was not filled at that time. Bethel Stewart Pickett, an Illinois graduate student and lately head of the horticulture department at the New Hampshire Agricultural College, has been appointed assistant professor of pomology. He brings an assistant with him from New Hampshire, Mr. J. J. Gardner, who will he an instructor in pomology. Dr. John Detlefson, lately of Harvard and Bussey Institution, Boston, has been appointed assistant professor of the new division of genetics in the animal husbandry department. Dr. Walter E. Joseph, of South Dakota Agricultural College, will be an instructor in animal husbandry, and V. A. Place, of Ohio State University, assistant in animal husbandry. Among the appointments made in departments allied to agriculture are those of Henry C. P. Weber, of the U. S. Bureau of Standards, as associate in chemistry, and of Otto Rahn, formerly of the Agricultural Experiment Station of Halle, Germany, and of the Massachusetts Agricultural College as assistant professor of bacteriology.

At the Minnesota Experiment Station in the division of agricultural engineering, Messrs. J. L. Mowry, H. B. Roe and A. M. Bull were promoted in May from the rank of instructor to that of assistant professor. A. V. Storm, professor of agricultural education, Iowa State College, has been elected professor of agricultural education. J. O. Rankin, assistant professor of economics in the Iowa State College, has been elected editor, with the rank of professor. Associate Professor W. H. Tomhave has resigned to accept a professorship in animal husbandry at the Pennsylvania State College. W. A. McKerrow was elected specialist in animal husbandry in the extension division with the rank of assistant professor, to succeed Mr. Tomhave. Professor Frederic H. Stoneburn, of the Connecticut Agricultural College, has been elected professor of poultry husbandry.

Mr. E. R. Garrett, of the University of Oklahoma and the Oklahoma Geological Survey, has been appointed assistant in mineralogy at Northwestern University.

Dr. John Sundvall, of Baltimore, has been appointed professor of anatomy, and Mr. Lindsey S. Milne, M.B., Russell Sage Foundation, has been appointed professor of medicine, in the University of Kansas.

The following changes in the department of anatomy of the University of Pittsburgh Medical School are announced: Herbert Hays Bullard, A.B., A.M. (Missouri), Ph.D. (Tulane), for the past three years instructor in anatomy in Tulane University Medical Department, to be instructor in anatomy and neurology, vice Dr. Edgar Davidson Congdon, resigned; Harry Ryerson Decker, A.B. (Princeton), M.D. (Columbia), to be instructor in anatomy; promoted from a demonstratorship.

Mr. F. J. Kean, lecturer in civil engineering at Leeds University, has been appointed lecturer in machine designing and experimental engineering at McGill University.

Dr. Ashley Watson Mackintosh has been appointed regius professor of medicine in the University of Aberdeen, in the place of Professor David White Finlay, who has resigned.

DISCUSSION AND CORRESPONDENCE

A KEY TO BASIN-RANGE STRUCTURE IN THE CRICKET RANGE, UTAH[1]

To the Editor of Science: Basin-range structure has been the subject of prolonged discussion, but the areas affording clear and unobliterated evidence of the movements to which the ranges have been subjected are comparatively rare. During a reconnaissance of Utah made the summer of 1905 the writer traversed the Cricket Range and mentally reserved to future leisure the more careful study of the structure he observed. Of this there seems to be no immediate prospect and the following information is communicated in order that it may be available to any geologist who may be fortunate enough to get within striking distance of the place.

The Cricket Range, locally known as the Beaver River Range or the Beaver Mountains, lies near the center of Millard County, Utah, and is northwest of the town of Blackrock on the San Pedro, Los Angeles and Salt Lake Railroad, 185 miles southwest of Salt Lake City. The southern part of the range (just west of Blackrock) is composed of several parallel and more or less uniform north-and-south ridges a few hundred feet high separated by comparatively smooth valleys a half mile or more in width. In each of the ridges is exposed practically the same succession of Middle Cambrian strata, dipping a little north of east at angles of from 20 to 30 degrees, and the group of ridges and valleys appears to duplicate in miniature the essential features of the entire Great Basin province. In the vicinity of Cricket Spring, which as near as can be remembered is not much over ten miles from Blackrock, the main part of the range begins and it is here composed, in large part at least, of Cambrian rocks like those of the southern ridges, but raised to considerably higher elevations and intersected by several north and south faults whose actual contacts may easily be observed. For example, the quartzites which form the base of the section on the west side of the range are repeated in the second canyon east of the spring. In this massive part of the range there is no doubt as to the presence of normal faults with the downthrow side to the west; it seems probable that the immediately adjacent succession of ridges to the south is to be attributed to similar causes, and that an examination of the zone between these two physiographic units will demonstrate their structural continuity. This easily accessible, though apparently overlooked, locality may thus prove to be a key to the Basin-range type of structure.

Lancaster D. Burling
Smithsonian Institution

[1] Published by permission of the director of the U. S. Geological Survey.

SCIENTIFIC BOOKS

Triumphs and Wonders of Modern Chemistry. A Popular Treatise on Modern Chemistry and its Marvels, written in Non-Technical Language for General Readers and Students. By Geoffrey Martin, B.Sc. (Lond.), M.Sc. (Bristol), Ph.D. (Rostock). New York, D. Van Nostrand Company. 1911. $2.00 net.

Popular treatises on science are generally regarded with disfavor by scientific men. This is not unnatural; for the most part those who are competent do not write and those who write are not competent. The scientific authority seems loath to demean himself by writing for the unscientific public, and the popularization of science is left to the newspaper reporter and the penny-a-liner. The reporter is catering to a popular demand and we ridicule or despise or ignore his futile but often honest efforts at interpretation in a field where he is clearly not at home.

It is unquestionably the scientist himself who is most largely to blame for this situation. He will not write himself, he looks askance at his fellow scientist if he ventures to write for the public and possibly dubs him a quack. We forget the marvelously fine work of Tyndall and of Huxley in popularizing science. After all, perhaps most men who are qualified from a scientific standpoint are really unable to put their knowledge into words which can be understood and enjoyed by the mass of mankind.

Of all the sciences possibly chemistry has suffered most from lack of popular interpreters. In Germany, Lassar-Cohn and Blochmann have in recent years presented chemical ideas successfully to the non-scientific mind, but there is little of value in English which can be called popular chemistry.

The book before us is a rather ambitious attempt to present the field of atomic and sub-atomic chemistry, as well as much of the chemistry of the non-metals, "in non-technical language for general readers and students." That the attempt is ambitious is apparent from the titles of the fifteen chapters, viz.: The Mystery of Matter; The Underworld of Atoms; Distribution and Evolution of the Elements; The Wonders of Chemical Change; Water; The Element Hydrogen; The Air; Oxygen, the Life-supporting Element; Nitrogen; Carbon—a chapter which concludes with The Wonders of Atomic Structure of Carbon Compounds; Carbon Dioxide; Silicon and its Compounds; Sulphur and its Compounds; The Phosphorus Group of Elements; Fire, Flame and Spectral Analysis.

The first five chapters are thus occupied with the most difficult problems of theoretical chemistry. How far they will be comprehended by non-scientific readers is a question. It would be interesting to try them as collateral reading for a class of beginners in chemistry. If an hour's interesting reading could be substituted for weary weeks of lectures, recitations and laboratory, it would be a great saving to both instructor and student.

Truly, there is not a page that can be considered dull reading. It is well that "Wonders" is a part of the title, for there is hardly a "wonder" in all the field treated, which is not introduced in vivid, often perhaps lurid, language. The style and scope of the book are best shown by a few quotations, which speak for themselves.

In the chapter on Air, we read of the future of this earth:

> Last of all, when the temperature falls below — 210° C., the air will freeze to a solid layer of an ice-like transparent mass about thirty-five feet thick. No gaseous atmosphere will then exist upon the earth. This will become an intensively cold dark wilderness. Then, after untold ages of ceaseless movement and gigantic change, the surface of our planet will at last rest in supreme repose, motionless and utterly silent. For, in the absence of a gaseous envelope, no moan of wind or roll of thunder, no splash of rain, no roar of torrent, no sound of voice of man or beast or bird, can pierce the blackness of the night and break its everlasting calm. The surface of the world will be a vacuum as perfect as that prevailing in Dewar's vacuum-jacketed flasks. The stars will shine out of a coal-black sky upon a lifeless world, set stiff and hard in the rigid grip of death, circulating

unseen and ghostlike in the darkness around a burnt-out sun. Yet, only a few miles down in its interior, in strange contrast to the dreadful death-bringing cold of its surface, the gigantic furnaces of the deep, immense reservoirs of power and energy, will still gleam and glow. So the world will continue for long eons of ages, until its matter dissolves away and rushes into the oblivion of the ether, or until it is shattered in some mighty cosmical collision and resolved into a glowing nebula again, only to begin anew another vast cycle of life (p. 159).

Again, of the electrons:

This primary stuff is negative electricity, which is therefore a true chemical element. A flash of lightning consists of the swift rush of innumerable myriads of these negative electrical atoms, flying with the enormous speed of a hundred thousand miles and more a second. An electric current flowing along a wire consists likewise of a torrent of these particles flashing along between the atoms which make up the wire. Light is but the swift shudder of the ether set up by the rapid whirl of these negative electrons round their tiny orbits in matter atoms. All the atoms of the elements consist of aggregations of many thousands of these bodies and originated in very different quantities, as follows: In the very beginning of time, long before Man, Earth, or Sun had come into existence, before even there was a suspicion of their formation, space was filled with a vast sea of electrical vapor. The vapor was composed not of atoms, for matter atoms had not yet come into existence, but of the tinier electrical particles mentioned above, the measureless speed of whose motions caused the whole to thrill with a faint crepuscular light, and appear from a great distance as a faintly luminous cloud, like one of the nebulæ which gleam nightly at us down from the sky.

The vapor, being composed of electrical atoms, was electrified beyond all measure, and stretched gleaming with its electrical fires, through the darkness of space like a flaming sword.

. . . In the earliest nebulæ—the first stage of matter of which we have any knowledge—there exist only four elements, namely, two still unknown upon the earth, together with hydrogen and helium. These are the four elements from which all the others have been formed, and these authors (A. C. and A. E. Jessup) term them "protons" to distinguish them from the other elements. The electrons are supposed to condense about the atoms of these protons in concentric rings; so that in order to imagine the appearance of an atom, we must look upon it as composed of a series of rings of various sizes, whose particles are in exceedingly rapid motion, and indeed, as we shall see presently, the stability of the rings is a consequence of the rapidity of the motion of the particles of which they are composed (pp. 37, 39).

Of the velocity of electronic motion:

Tremendous as the velocities reigning in the molecular world may seem to us at first sight, yet they are quite insignificant when compared to the swiftness of the whirling motions going on within the atoms themselves; the particles building up the atoms flash through over a HUNDRED THOUSAND MILES A SECOND! Incredible, you will say; nevertheless it is a sober fact of science. In every stone and stick about us, ceaselessly, second by second, day by day, century by century, age by age, these terrific motions are going on. In the tiniest grain of dust in the millionth part of a second the rush of atomic events is so incredibly swift as to defy all conception and calculation (p. 21).

If an intelligent inhabitant of our electronic microcosm were suddenly transferred to our world, and managed to retain his mental characteristics unchanged, our life here, busy as it seems to us, would represent to him a changeless eternity, since in a single second of our time the electronic world has time to revolve billions of times round its central sun. His atomic years are almost infinitely shorter than ours and his sense of time almost infinitely finer. Time and space are, after all, merely relative conceptions (p. 81).

Under Hydrogen is the story of some fragments of zinc carelessly left inside the boiler of a German warship:

The hold was filled with busy stokers, and the great engines throbbed, driving the mighty vessel swiftly through the sea. All this time the water was heated in the boiler to an exceedingly high temperature and the zinc was dissolving rapidly in it, giving off a large amount of hydrogen gas. This mingled with the air in the boiler to form a terribly explosive mixture, so, all unknown to the men working around, the great boiler was gradually filled with the deadly gaseous mixture. Suddenly, without a moment's notice, with a blinding flash of light and a roar like an enormous thunder peal, the great boiler blew to pieces, killing or maiming all the men in the room and filling the vessel with a cloud of scalding steam (p. 111).

These quotations will suffice to show the characteristics of the book. It can hardly be considered as other than somewhat sensational and often perhaps exaggerated, but to the student of chemistry it will afford much food for thought and reflection, and this, we think, is its chief value. The title of "Modern Chemistry" is well chosen, for the book is brought thoroughly down to date.

The illustrations are unequal. Some of the half-tones are excellent, while some of the wood-cuts are execrable, wholly unworthy of the book, and others have evidently been handed down from early times. Quite unique are the three cuts representing the reaction between phosphorus pentachlorid and sulfuric acid, which have a decidedly astronomical appearance, cometic, one might say.

The book is printed on thick, light paper and the typography is good. The only error we have noticed is the name of F. W. Clark instead of Clarke, and this is several times repeated.

J. L. H.

Ctenophores of the Atlantic Coast of North America. By Albert Goldsborough Mayer. Publications of the Carnegie Institution, 162. 1910. Pp. 58; pl. 17.

Dr. Mayer is well qualified to give an account of our ctenophore-fauna by many years observation at numerous localities between Newfoundland and the West Indies, all but three of the 21 species here recorded having come under his own observation. And his book is made doubly welcome by the fact that American ctenophores have received little attention in recent years.

The first few pages are devoted to a brief statement of geographic distribution, three groups of species being recognized on our coast: "cold-water forms," "intermediate" and "tropical." The first are described as common north of Cape Cod, and occasional as far south as Hatteras, the second extending from Cape Cod to northern Florida, while the records of the tropical species are chiefly from the Tortugas, though some of them "drift northward in summer to the region of Vineyard Sound." The recognition of these three groups is justified; but exception must be taken to the limits assigned the first, for two of its members, *Pleurobrachia pileus* and *Beroe cucumis* are by no means exclusively cold-water species, as is shown by the presence of the former at Bermuda, in the Mediterranean and at the Seychelles, and of the latter near Madagascar and in the Malay archipelago. Mayer suggests that the Mediterranean "Pleurobrachias" might be young Lobatæ, but specimens from Naples prove to be typical *P. pileus.* If we remove these two species from the Arctic group, the extreme southern limit of the latter in winter appears to be New Jersey. The tropical group includes the noteworthy species *Hormiphora plumosa, Eurhamphea vexilligera* and *Folia parallelum,* not previously recorded from this side of the Atlantic. An interesting fact pointed out by Dr. Mayer is that we are far less rich in ctenophore species than the Mediterranean; though certain ones swarm on our northern coasts.

The general organization of the ctenophores has so often been discussed that Dr. Mayer limits himself to a brief summary of the features of the gastrovascular system of the six orders, and then proceeds to the descriptions of the species, which occupy the greater part of the volume. These are generally satisfactory, the lists of references full, and the figures numerous and unusually beautiful, and there are numerous notes on habitat and on physiology. No families are recognized, the only divisions being orders, genera and species. The following generic names are abandoned, because preoccupied, *Bolina, Eucharis, Ocyrœ* and *Vexillum;* as substitutes Dr. Mayer proposes *Bolinopsis, Leucothea* (Mertens), *Ocyropsis* and *Folia.* Four species are described as new, *Pleurobrachia brunnea, Tinerfe lactea, T. beehleri* and *Leucothea ochracea.* But the first is so close to the *Hormiphora spatulata* described by Chun from the Plankton expedition that I believe the two are identical. *Leucothea ochracea* is interesting because, to judge from analogy, we might expect the Tortugas representative of the genus to be identical with the eastern Atlantic and Mediterranean species. But Dr. Mayer has studied both in life, and the differences between them, particularly the presence of lateral tentacular filaments in *ochracea*, are too important to be considered individual variations.

The section dealing with the Lobatæ deserves special notice because of the excellent accounts of *Bolinopsis vitrea Mnemiopsis mccradyi*, *M. gardeni* and *Ocyropsis crystallina*, the earlier descriptions of which were unsatisfactory. These two species of *Mnemiopsis* are closely allied to the well-known *M. leidyi*, but the differences are constant, though slight. Unfortunately, the status of the other West Indian *Ocyropsis*, *O. maculata* Rang, is still doubtful, as Dr. Mayer never saw a specimen, and the same is true of *Lesueria hyboptera* A. Agassiz, which he suspects is "only a *Bolina infundibulum* with its oral lobes torn off, and the edges healed over."

Under the Beröidæ Dr. Mayer recognizes only one genus, *Beroe*, believing that *Pandora* is a young stage. On this he differs from Moser, and from the writer. Probably the last word on this point is yet to be spoken. Two species of *Beroe* are listed from our coast, *cucumis* and *ovata*, the latter including *clarkii* and *shakspeari*, and, I believe, correctly. The figure of the adult *ovata* is welcome, because many of the records of this species in the past have rested on insufficient evidence. *B. forskalii* is not included, as it has never been taken in American waters. But judging from its wide distribution in warm regions, it may be expected on our southern coast. Finally there is a brief account of the remarkable Greenland Platyctenid *Tgalfiella tristoma*, condensed from Mörtensen's preliminary description. His final paper has appeared in Vol. 5 of the Danish Ingolf Expedition.

Students will find in this book a convenient manual for a group, the previous literature of which is scattered and largely inaccessible.

Henry B. Bigelow

Evolution in the Past. By Henry R. Knipe, F.L.S., with Illustrations by Miss Alice B. Woodward and Ernest Bucknall. London, Herbert & Daniel. 1912. Pp. xvi + 242, 4 text figures and 56 plates. 4to.

A few years ago the author published a profusely illustrated work entitled "From Nebula to Man" in which in metrical form he gave a sketch of the gradual development of our earth from a nebular mass and of the evolution of living forms upon the globe. The difficulty of forcing the jaw-torturing nomenclature of the paleontologist and zoologist to adapt itself to the requirements of smoothly running blank verse revealed itself in the author's epic, and it is with a certain sense of relief that we turn from the earlier work to the present, in which in plain prose he brings together and outlines the gradual unfolding through successive geologic periods of the story of evolution.

The author has evidently read widely and familiarized himself with the latest results of scientific research in the domain of paleontology. His statements as to the different geologic periods and the forms of life which characterized them are in accord with the most advanced teaching of the present. The style of the book is popular, so far as it is possible to make any subject popular which deals with words of Greek origin, which are only in current use among specialists and students. The paleontologist, who is forced to frame names for newly discovered forms of animal life which existed in a past more or less remote, is at a disadvantage when writing of these things when compared with the man who has to deal with recent forms of life, which are known all over the globe by vernacular names. A man who writes about elephants, tigers, bears, and wolves, who discourses of thrushes and nightingales, who speaks of crocodiles and sharks, or bugs and snails, is comprehended even by children; but the man who writes about trilobites, ichthyosaurs, diplodocuses, dœdicurus and pliopithecus is apt to be regarded with breathless amazement by the uninitiated. An amusing illustration of this occurred recently when the present reviewer, standing in the museum of which he is the director, was engaged in a lively conversation with Col. Roosevelt about the evolution of mammalian life in North America. A score of newspaper reporters surrounded the speakers, and one of them subsequently published an account in which he said that a most astonishing conversation in language absolutely unintelligible to the listeners took place between the ex-president and the director of the museum.

The publication of such works as that which has appeared from the pen of Mr. Knipe will tend in the future to make the subject more intelligible to the ordinary reader and the association of the names of things with splendid illustrations of them must familiarize the public with the whole subject.

Too much praise can not be bestowed upon the fine plates which adorn the volume. They are the product of the facile pencil of Miss Alice B. Woodward, the talented daughter of Dr. Henry Woodward, the late curator of geology and paleontology in the British Museum, and Mr. Ernest Bucknall. A few of these originally appeared in the author's first volume, but the great majority are new.

W. J. Holland

NOTES ON METEOROLOGY AND CLIMATOLOGY

A RAINLESS APRIL IN ENGLAND

April last was the driest month on record over a large part of England. In London but 0.04 inch of rain fell, making this month the driest of that name in about a century and a half, which is the length of the record. In the last half-century only one month, February, 1891, had less precipitation. At another station, Bromley, where a record has been kept since 1869, April, 1912, was the first month in which *no* precipitation was recorded.

THE RECORDING OF EARTHQUAKES

It is particularly unfortunate that congress did not see fit to make an appropriation for the inauguration of seismological work under the auspices of the U. S. Weather Bureau. Two seismographs have been in operation at the central office in Washington for a number of years, but no work of this character has been done at any of the other stations, notwithstanding the general call from a number of sources that the weather bureau engage in this important work. While not strictly meteorological in character this work is carried on by the weather services of most countries, principally because in each country it is the one government scientific bureau having permanent stations at scattered points, with a trained body of observers to conduct the work. In the United States good work has been done by various educational institutions, particularly those of the Jesuit order. However, it has been the experience of other countries that seismological observations can be obtained to greatest advantage by a government bureau through the use of standard instruments, permanently established and having similar environments. In the United States the weather bureau seems best equipped for such work.

THE ATMOSPHERE AT GREAT HEIGHTS

Luminous phenomena like meteor trains and auroras at heights of 200 kilometers (124 miles) or more have long proved the existence of some atmosphere, however tenuous, even at these great heights. According to Professor W. J. Humphreys, the atmosphere at a height of 150 kilometers (93 miles) consists of 99.73 per cent. (by volume) of hydrogen and 0.27 per cent. of helium, with a total pressure of 0.0043 in millimeters of mercury. As a result of recent investigations, Dr. A. Wegener concludes[1] that there is an atmosphere of perceptible density even up to 500 kilometers (311 miles) and that in the highest strata there must be an unknown gas in addition to and lighter than hydrogen. He suggests that this gas be called "geocoronium" because of its similarity to "coronium" which is supposed to exist in the atmosphere of the sun.

[1] *Himmel und Erde*, July, 1912.

FREE AIR DATA IN FORECASTING

When the exploration of the upper air by means of kites and balloons was first attempted about fifteen years ago, many meteorologists with more enthusiasm than judgment stated that forecasting would soon be simplified because of the upper air data thus derived, and that the weather of a week or a month ahead would be foretold with as great certainty as that for the next 36 hours was then predicted. However, the application of the knowledge gained from soundings in the free air has not been a simple matter. In fact the problem has been a very complex one, and thus far investigations in aerology have been mainly along the lines of pure science. The normal condition of the free air is just now beginning to be understood, and as yet, abnormal conditions and their relation to subsequent weather changes at the ground have not been thoroughly investigated. Various changes aloft, particularly those relating to wind velocity and direction, frequently become apparent at the ground six to eight hours later. If this is generally true, weather data from aloft will never be particularly serviceable to the forecaster because of the short time interval involved. At Mount Weather Observatory, one of the best equipped aerological stations in the world, attempts have been made, with fair success, to use the data from aloft in connection with the Washington forecasts. Moreover, after the weather maps have been drawn the free air conditions preceding and accompanying the weather at the ground have been studied with a view of determining the forecasting value of the data from aloft. That the hopes expressed fifteen years ago have not yet been realized may be seen from the following statement of Professor A. J. Henry,[2] Executive Officer of the Observatory:

> While a large number of barometric depressions passed over Mount Weather during the month (March), a careful study of the upper air data on the day previous to the advent of each depression does not show, as yet, that decided changes are in progress whereby the course or the intensity of the depression might be inferred.

[2] *Monthly Weather Review*, March, 1912, p. 473.

PERIODICITY IN PRESSURE VARIATIONS

Well-marked periods of three and one half years have been observed in the pressure variations at Port Darwin, in the northern part of Australia. From a study of the mean monthly values for 1878 to 1911, Dr. C. Braak[3] finds that similar changes also occur in India and throughout the Malay Archipelago, and associated with them are variations of temperature with maxima half-way between the maxima of pressure. It has generally been supposed that solar changes account for the temperature variations, which in turn produce variations in pressure. However, when the temperatures and pressures are plotted it appears that a pressure wave resembles the temperature wave which follows it rather than the one which precedes it, indicating that the changes in pressure cause the changes in temperature, and not conversely. Dr. Braak describes the process somewhat as follows: Through some cause pressure becomes high over the region. The wind thereupon becomes feebler and the air takes less part in the general circulation than usual. Diminished air circulation means diminished oceanic circulation; consequently air and water become relatively stagnant, and are hence subject to the continued action of the tropical sun, which gradually increases the temperature, and finally produces a maximum in the temperature curve. The increase goes on until the effect of the high temperature on the pressure is to diminish it and eventually to replace it with a generally low pressure. Conditions are now reversed, for low pressure means increased wind velocity, and a considerable interchange of air and water between equatorial and temperate regions, resulting in a lowering of temperature in the equatorial region. Ultimately this temperature change increases the pressure, until high pressure is once more restored and the cycle begins again. The pressure and temperature changes are

[3] *Meteorologische Zeitschrift*, Vol. 29, pp. 1–7.

thus ascribed to terrestrial and not to solar influence.

THE NEED OF A METEOROLOGICAL LABORATORY

Professor Cleveland Abbe, who in January last was awarded the Symons Gold Medal by the Royal Meteorological Society for his contributions "to instrumental, statistical, dynamical and thermodynamical meteorology and forecasting," has communicated an interesting paper to the Franklin Institute, Philadelphia, on "The Obstacles to the Progress of Meteorology." In it he says that even if we had perfect observations and records for ages past, with free air data up to heights of ten or fifteen miles, together with daily weather maps for the whole northern hemisphere, perfect weather predictions could not now be made because of "our ignorance of many details as to the laws that govern the atmosphere and our inability to put even what little knowledge we have into such a form that it can be perfectly utilized by the forecaster." He shows that in every branch of science progress has been accomplished mainly through laboratory observation and experiment, guided by the spirit of mathematics. He therefore says in concluding:

> What I most long to see, and what I believe is of fundamental importance in atmospherics—the want of which is a real obstacle—is the existence of a laboratory building specifically adapted to atmospheric experiments, and the association therewith of able students trained in mathematics, physics and mechanics. When all this is realized the intellectual work that will there be done will gradually remove all obstacles to the eventual perfection of our knowledge of the atmosphere.

NEW BOOKS

Among the books which have recently appeared are: (1) "Climate and Weather," by H. N. Dickson. London, Williams and Norgate, 8vo, 256 pp., 1s. net. (2) "Instructions Météorologiques," by Alfred Angot. 5th edition. Paris, Gauthier-Villars, 8vo, 161 pp. (3) "International Catalogue of Scientific Literature"—"Meteorology, including Terrestrial Magnetism." London, Harrison and Sons, 8vo, 238 pp., 15s. (4) "Atlas Photographique des Nauges," by J. Loisel. 8 pp. + 10 pl., Paris, G. Thomas, 18 fr. (5) "The Structure of the Atmosphere in Clear Weather: a Study of Soundings with Pilot Balloons," by C. J. P. Cave. 4vo, 144 pp., Cambridge University Press, 10s. 6d. net. (6) "Meteorological Instruments and Weather Forecasts," by H. T. Davidge. London, P. Marshall and Co., 6d. net. (7) "Barometers and the Measurement of Atmospheric Pressure," by C. F. Marvin. 4th edition, 8vo, 110 pp., Washington, U. S. Weather Bureau, Instrument Division, Circular F. (8) "Evaporation from Irrigated Soils," by S. Fortier and S. H. Beckett, 8vo, 77 pp.. Washington, U. S. Office of Experiment Stations, Bulletin 248.

Andrew H. Palmer
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SPECIAL ARTICLES

THE PHYSIOLOGICAL SIGNIFICANCE OF THE SEGMENTED STRUCTURE OF THE STRIATED MUSCLE FIBER

The question of the physiological significance of the segmented structure of striated muscle fibers remains for most physiologists one of the standing enigmas of their science. What relation—if any—has this structure to the power of rapid and instantly reversible contraction which is the distinctive peculiarity of this tissue? No entirely satisfactory answer to this question has hitherto been found; those which have been proposed are as diverse as their authors' conceptions of the ultimate of the difficulty lies here. The histological literature is full of contradictions and hence —since all can not be right—of misinterpretations. Before agreement can be reached on the physiological question, it is evident that a clear and satisfactory conception of the essential structure of the living muscle-cell is necessary. Many of the structural minutiæ visible in histological preparations vary according to the nature of the treatment accorded the tissue. Their physiological significance is thus doubtful. During recent years a certain change in the procedure of investigators has become apparent. Experience of the readiness with which the structure or "aggregation-state" of a colloidal system may be altered has made it clear that such structures are not always to be regarded as preexistent in the living tissue. They are rather to be regarded as appearances from which, on the basis of an adequate knowledge of the behavior of colloidal systems under similar treatment, inferences may be drawn as to the original disposition and state of the colloidal material in the living system. Inferences so drawn require to be controlled by an exact knowledge of the structural appearances in living muscle during both rest and contraction. Hence recent investigators—as Hürthle and Meigs—have relied mainly on direct and photographic observation of living muscle fibers. But even results so gained show considerable disagreement in detail, and unfortunately they have proved compatible with diametrically opposed conceptions of the essential nature of the contractile process.

Certain definite conclusions have, however, been reached. It is agreed that the contractile elements are solid fibrils—consisting supposedly of water-swollen myosin—which are embedded in a more fluid sarcoplasm; the fibrils are not optically homogeneous, but exhibit a regular alternation of longer segments consisting of more refractive and largely doubly refractive (anisotropic) material, with shorter less refractive segments showing little or no double refraction (isotropic). In the voluntary muscle-cell of vertebrates the fibrils are crowded together closely, and in such a manner that the adjacent anisotropic and isotropic segments of different fibrils lie at the same level; this level is perpendicular to the long axis of the muscle cell, hence the latter, as a whole, shows the characteristic cross-striation. It is this peculiarity of parallelism in the disposition of the fibrillar segments which Hürthle characterizes as "schwer verständlich." It plainly suggests that the fibrils are laterally conjoined in a definite manner so as to form a system coherent throughout the cell. Conceptions differ, however, as to the ultimate structure of the individual fibrils, and particularly as to the nature of the conditions producing the segmented appearance.

I shall not attempt in this place to discriminate minutely between conflicting views regarding structure; my aim is merely to show that a segmented structure is in itself—and largely irrespective of the precise nature of the structural conditions that determine the segmentation—a condition favorable to rapid and quickly reversible changes of form. The questions to be discussed are thus: What mechanical advantage does a rapidly contractile colloidal system like muscle derive (1) from having its fibrils regularly and minutely segmented, and (2) from having the corresponding segments of adjacent fibrils at the same level?

Considered from a physico-chemical point of view, the individual muscle-fibril forms a colloidal system in which regions showing a well-marked contrast in optical and apparently also in chemical properties (evidence from staining) alternate regularly with one another. It is, however, doubtful if the alternate segments differ in their essential chemical constitution; the evidence seems rather to indicate that the same colloidal material forms the solid substratum of the fibril throughout its entire length, but that this material differs in its state of aggregation in alternate segments. The colloidal particles must be regarded as forming a coherent system throughout the entire fibril, as in a gel; otherwise the fibril would have no tensile strength. Between the coherent particles of any gel are interstitial fluid-containing spaces.[1] If the fibril is essentially a gel, as thus assumed, with myosin as the chief colloid, its physical

[1] The recent observations of Bachmann, made in Zsigmondy's laboratory, on the ultramicroscopic structure of gels, show that during gelation the motion of the submicrons changes from one of a free translatory character to one in which the submicrons undergo only slight vibratory movements about fixed positions of equilibrium. There is thus in gelation an aggregation of submicrons and amicrons to form a coherent system, with fluid-containing interspaces. Cf. *Zeitschrift für anorganische Chemie*, 1911, p. 125.

condition from segment to segment can vary only in the concentration and state of aggregation of its colloid material. There are indications that the colloidal particles (probably submicrons) are more densely aggregated in the dim bands and less densely in the light; in this case the interstitial spaces must be smaller in the dim and larger in the light bands; *i. e.*, the proportion of displaceable fluid material is greater in the light bands, the latter, so to speak, having the looser texture of the two. Such a conception explains many characteristic observations, such as the beaded form shown by fibrils under certain conditions; the greater compressibility of the isotropic segments (indicating a greater fluidity), as shown by the experiments of Haycraft, who obtained impressions of the segmented structure by pressing living fibers against collodion; the facts that the double refraction appears rather to diminish than entirely to disappear in the light bands, and that adsorbed coloring materials, such as hæmatoxylin, though taken up by the whole fibril, are extracted most readily from the isotropic segments, just as though the adsorbing surface were there relatively less. Hürthle also compares the material composing the fibril to a gel; he regards this as chemically homogeneous throughout, but as differing in its physical condition in alternate segments. He adduces the analogy of the nodes in a stretched vibrating string, implying that the differences between the alternating segments are purely physical and independent of differences in chemical composition. Although it is doubtful that marked differences in the colloidal aggregation-state could exist between adjacent segments without at least some quantitative differences of chemical composition due to differences of adsorption, etc., yet the essential conception of the fibril as essentially homogeneous in its chemical composition is not altered by recognizing the existence of a segmented structure of the above conceived kind.

On this view the fibril is to be regarded as a column of colloidal material having the essential properties of a gel—*i. e.*, a system in which the colloidal particles cohere; the particles, however, are not homogeneously distributed in this gel, but are relatively densely aggregated in the anisotropic segments and loosely in the isotropic; in the latter the interstitial fluid-containing spaces are therefore relatively larger. It should be noted that in all muscles the isotropic segments are shorter than the anisotropic; also that the best photographic evidence indicates that the actual shortening is confined to the anisotropic regions of the fibril, *i. e.*, to the regions where the colloidal particles are the most closely aggregated. The significance of this will be apparent later.

The considerations urged in the preceding paragraph relate to the individual fibril and do not explain the lateral coherence of the fibrils. It seems clear, from the fact that the striation is preserved during contraction, that transverse connections must exist between adjacent fibrils, otherwise the latter would certainly undergo relative displacement more frequently than observation shows to be the case. But the histological evidence of such cross connections is imperfect, although the view seems well founded that the appearances known as Hensen's and Krause's lines (*M* and *Z* lines) correspond to regions where adjacent fibrils are laterally conjoined. This view is supported by Heidenhain on the basis of numerous observations on fixed muscle of various kinds; and a continuity of the *Z*-lines from fibril to fibril, even when the latter are separated by some distance, is clearly apparent in some of Meigs's photographs. Both of these appearances, especially the *Z* or intermediate line, have been interpreted as membranes subdividing the fibrils at segmental intervals; but they seem to lack the continuity which such a conception demands. A continuous membrane would show definite optical appearances due to reflection of light at its surface. The so-called *J*-lines, which suggest such reflection and hence support this conception, are variable and often unapparent. On the other hand, the existence of narrow cross-connections between adjacent fibrils would undoubtedly account for the observed appearances. I am, therefore, inclined to favor this interpretation. According to this conception these structures are of no essential importance in contraction except in so far as they prevent relative displacement of adjacent fibrils. But such displacement, if permitted, would interfere with the contractile properties of the system, as I shall show later, so that the physiological rôle thus assigned to these structures may after all be indispensable. This view is however quite opposed to any hypothesis—like that of Pütter—which regards the intermediate lines as corresponding to membranes whose state of permeability determines the degree of osmotic distension of the muscle segments, and so the state of contraction. The evidence of their membrane character seems insufficient to serve as support for such a speculative view as this. On the other hand, the lateral coherence of the fibrils is an undoubted fact which must have a structural basis, and direct observations exist which indicate that at least the *Z* lines—which appear to be the more constant of the two—do in fact cross the intervals between the fibrils. Structures thus continuous from fibril to fibril are most naturally interpreted as connectives.

We may now consider the physiological problem as to the nature of the essential physical changes which form the direct condition of the characteristic mechanical deformation of active muscle. The precise nature of the energy-yielding metabolic process need not concern us here. As well known, various more or less seriously conflicting hypotheses exist. There is considerable evidence of a displacement of fluid within the contractile elements during activity, and this fact has led to the development of theories which assign to this transfer of fluid the essential rôle in the process of contraction. Thus Engelmann and many others have referred the process to a water-absorption or swelling of certain structural elements—just as gelatine sheets swell in water, and more rapidly when the water is warm or acidulated than when it is cold or neutral. The general structural conception put forward some time ago by McDougall, and recently favored by Meigs and others, has been that of a tissue composed of elements comparable to somewhat elongated or spindle-shaped fluid-containing sacs with inextensible walls; these elements on distension approach a spherical form, with consequent approximation of their opposite ends. A certain degree of shortening (about 37 per cent.) may thus theoretically be accounted for. That the actual shortening often greatly exceeds this proportion is unfavorable to such hypotheses, though perhaps not necessarily incompatible with them. The structural conditions might conceivably be such that the swelling elements at their maximal normal distension adopt a form in which the ratio of transverse to longitudinal diameters—assuming these to correspond with those of the muscle-cell—is increased sufficiently to account for a much greater degree of shortening than the above. All that would be necessary to render such a hypothesis adequate in this respect would be to assign a certain definite structure and form to the elements. Take for instance the case of a tissue composed of structural units resembling the extended elaters of the spores of *Equisetum;* as is well known, these structures when slightly moistened wind themselves closely around the spore; the total diameter of the system, spore *plus* elaters, may thus be reduced to a small fraction of the original diameter as measured between the tips of the extended elaters. One might conceive of muscle as composed of elements similar in contractile properties to elaters, united in a definite manner to form a contractile system; and it would no doubt be possible, by exercising some ingenuity, to reconcile such a conception with the main histological appearances. Hypotheses that refer the contraction to swelling of the contractile elements are thus not to be dismissed by advocates of other views as inadmissible on the ground of purely geometrical considerations. The objections to this type of explanation are of quite another nature; and since they are in my opinion sufficiently weighty to render it extremely doubtful that this kind of physical charge could ever form the basis of a movement so rapid, responsive and quickly reversible as muscular contraction, I shall briefly recapitulate what I consider to be the chief inadequacies of such hypotheses.

(1) The time required for a contraction and relaxation due to swelling-changes in the colloidal contractile elements—involving both the incorporation of water into the colloid and its release—seems to be too great. Pauli, indeed, once estimated that if the elements have the swelling properties of gelatine discs, and the same surface-volume ratio as the muscle-segments, the rate of swelling might be sufficient to account for a contraction as rapid as that of frogs' muscle. But the single twitch may be many times shorter than this, as in insects' wing-muscle, where moreover the muscle-segments are larger than in vertebrate muscle. It is of course possible to reply to this objection that the actual elements concerned may be much smaller than the visible muscle-segments. Still, in any case, since the single-twitch curve of striated muscle is symmetrical, the rate of the water-absorption would have to correspond in its time-relations with that of the water-loss. These curves, however, have been shown to follow different courses in those cases which have been actually investigated (by van Bemmelen). (2) A more serious difficulty is that the temperature-coefficient of the mechanical energy of contraction, according to Bernstein's investigations, is *negative; i. e.,* within a normal range—up to 30°—the lifting power of the twitch is *increased,* with a given intensity of stimulus, by lowering the temperature. The temperature-coefficient of swelling processes is however positive and large, like that of chemical reactions; that of surface tension, on the contrary, is negative. Bernstein's experiments must be regarded as very significant, since the temperature-coefficients of the chemical changes concerned in contraction are of course positive; the above result would seem therefore quite unaccountable if a chemical change, like the production of acid, preceded and formed the condition of the contractile change. These experiments thus appear to indicate, first, that the process immediately conditioning the contraction is only indirectly dependent on a chemical change,[2] and, second, since this process has a negative temperature-coefficient (a distinctive peculiarity of surface-tension), that a change of surface-tension in the ultimate contractile elements is the direct source of the energy of contraction. (3) A further disadvantage of the "swelling-hypotheses"—as contrasted with the surface-tension hypothesis—is that they offer no suggestion as to the nature of the connection between the electrical variation accompanying contraction and the actual contractile process. In electrical stimulation a change in the electrical polarization of the plasma-membrane is almost certainly the essential or critical event. If the membrane enclosing a colloidal system, such as a muscle-cell, changes its polarization, a corresponding change of polarization must occur at *all* of the electrically polarized surfaces within the system thus enclosed,[3] including presumably the surfaces of the colloidal particles composing the contractile elements. Changes of electrical polarization at surfaces are definitely known to alter the surface-tension. On the other hand, the relation assumed to exist between the polarization-change of stimulation and the swelling of the colloidal elements, according to the hypothesis under consideration, must be exceedingly indirect. A chemical change must first be assumed to occur, producing substances, supposedly acid, which increase the swelling properties of the colloid. There is nothing unreasonable in this view, but it fails to suggest any explanation of the close parallelism which exists between the electrical and the contractile processes in active muscle. The interdependence between the two is undoubtedly intimate, and is readily intelligible on the hypothesis just outlined

[2] Resembling in this respect the plant-movements due to changes in the permeability of the plasma-membranes of turgid cells (in *Mimosa, Dionœa,* etc.).

[3] Since the electrical potential of the whole cell-interior changes, and with it one of the factors in the conditions of equilibrium of the electrical double layers at the polarized surfaces within the cell.

that alterations of the surface-tension of the contractile elements, conditioned by variations in their electrical surface-polarization, form the immediate condition of contraction. Any hypothesis which fails to explain this interconnection must be regarded as seriously deficient.

I shall now discuss more fully what is usually regarded as the alternative hypothesis, namely, that the contractile energy is due to changes in the surface-tension of certain muscle-elements. In contraction the surface-tension of these elements is supposedly increased. If this increase of tension is sufficiently great, and the area of the active surface sufficiently large, the transformable surface-energy, which is measured by the product of these two factors, may be sufficient to account for the work done by muscle in contraction. The main question is whether the evidence justifies us in assuming the existence of such conditions in the living muscle-cell. Now the possible range of alteration in the surface-tension of the colloidal contractile elements under the influence of changing electrical polarization is undoubtedly small—almost certainly less than ten dynes per linear centimeter—so that in order to develop the force observed in contraction a very large active surface would be required. Bernstein has shown that any possible alteration of surface-tension at the surface of the muscle-fibrils is quite insufficient to account for the work done by contracting muscle; and he has therefore assumed that in its ultimate structure the fibril is built up out of smaller ellipsoid contractile elements, by the alteration of whose surface-tension the contraction of the whole fibril is produced. By ascribing sufficiently small dimensions to these elements it is possible hypothetically to enlarge the surface to the required degree. But is such an assumption reconcilable with our present knowledge of muscle structure? In Hürthle's photographs the fibril-segments show a subdivision into narrower rodlet-like structures ("Stäbchen") which he regards as the ultimate contractile elements. The united surface-area even of these elements is also far from sufficient to meet the requirements. There are thus no microscopically demonstrable structures corresponding to Bernstein's hypothetical ellipsoids. It is necessary, if the hypothesis is not to be abandoned, to inquire if still smaller elements may not exist by the alteration of whose surface-tension the requisite mechanical energy may be produced. There is, as I have pointed out elsewhere, good reason to regard the ultimate colloidal particles of the fibrils as corresponding to such elements. By their union to form larger particles, as in the general process of colloid-coagulation, sufficient mechanical energy to account for contraction might conceivably be freed, since the reduction of surface-area in such a process may be very great, implying a correspondingly large transformation of surface-energy. It is known that in the precipitation of colloids by electrolytes a fundamental condition of the effect is a lessening of the contact-potential of the particles against the medium; the isoelectric point, where the contact-potential is zero, is typically the point of maximum instability, *i. e.*, the tendency to fusion of the particles is then greatest; apparently their surface-energy, then no longer compensated by the electrical energy of the charged surfaces, draws the particles together until a new condition of equilibrium with lessened surface is reached. Increased surface-tension resulting from decrease or disappearance of the surface-charges is in fact now regarded as one of the chief conditions determining the union of the colloidal particles to form larger complexes. This union, if it proceeds sufficiently far, leads to the coagulation or precipitation of the colloid.

Now if in a contractile tissue the mechanical energy appearing in contraction is the expression of a temporary coalescence of the colloidal particles of the fibrils, due to their increased surface-tension, any condition furthering contraction ought, if not rapidly reversed, to lead to further fusion of particles and eventually to visible coagulation. Various facts of comparative physiology show that during conditions of extreme contraction the colloids of contractile tissues do frequently undergo a more or less evident coagulation. The most striking instance known to me is that of the swimming plates of ctenophores; these structures, when immersed in pure isotonic solutions of sodium salts, exhibit for a short time an abnormally accelerated contractile rhythm accompanied by a progressive coagulation of the normally transparent contractile substance; this coagulation is the more rapid and complete the more energetic the contractile movements. Pütter in his recently published "Vergleichende Physiologie" cites (p. 456) a number of instances where contraction of muscle is accompanied by a visible coagulation of the muscle-substance. In vertebrate muscle the coalescence of colloidal particles—assuming it to take place—does not normally lead to visible coagulation during contraction. But it is characteristic of this tissue that the contraction is instantly and automatically reversed unless a rapid and rhythmical process of stimulation is continued. This peculiarity, which is perhaps the most remarkable property of this tissue, is favorable to, or at least quite consistent with, the view that a temporary coalescence of the colloidal particles occurs at each stimulation—due to a depolarization of the surface of the particles, simultaneously with a depolarization of the plasma-membrane of the entire cell—and that this coalescence is instantly reversed by the automatic return of the membrane to its normal polarized condition. If, however, the plasma membrane becomes *permanently* depolarized, as in consequence of any marked and permanent increase in ionic permeability (such as occurs during cytolysis), the coalescence of colloidal particles becomes permanent, and a visible coagulation, typically accompaned by a permanent shortening or "contracture," follows. Such an effect is produced if a frog's muscle is immersed in physiological salt solution containing saponin or other cytolytic substance. If the muscle is first sensitized by exposure for a few minutes to a pure isotonic solution of a sodium salt, such as iodide, the cytolytic action of the saponin is accelerated; the contraction is thus rendered quicker and more energetic and the degree of coagulation is greater; *i. e.*, the energy of the contraction shows a distinct parallelism with the energy of the coagulative process in the muscle-substance. It might be maintained that the coagulative change is merely a secondary consequence of the cytolysis, and has no direct connection with the contraction, but when these facts are taken in conjunction with the others cited in this paragraph the indications seem strong that the ultimate process causing contraction is essentially the same as that which —if carried far enough—leads to coagulation of the colloids. As already pointed out, the latter process is due to fusion of colloidal particles to form larger aggregates; what causes the union appears to be heightened surface-tension resulting from diminished electrical surface-polarization; the increased tension then draws the particles together and thus performs a certain mechanical work. Similarly in the contractile tissue; within each fibril the colloidal particles or submicrons—which presumably are already in contact or cohere since the whole fibril forms a solid gel-like system—draw together more closely during contraction in consequence of a sudden increase in their surface-tension. This coalescence occurs only within each fibril, not between adjacent fibrils, hence the motion of displacement of the particles is virtually limited to the direction of the long axis and in consequence the whole fibril shortens. As the coalescence of the particles proceeds the active surface-area steadily decreases, and with it the contractile force; hence this force is greatest at the beginning of contraction and diminishes as the muscle shortens.

We assume therefore that in contraction the colloidal particles, especially those of the anisotropic segments, draw together or coalesce. There is, in other words, a clumping or flocking of the particles, which is most rapid and energetic in those regions where the particles are most numerous and closest together. In so doing they displace the more fluid interstitial substance. This incidental displacement of fluid is as necessary an accompaniment of the act of contraction as the coalescence of the particles, and if the contraction is to be rapid and quickly reversible the movement of the fluid must be equally so. It is this consideration, in my belief, which explains the advantage of the segmented structure. The fluid displaced from each anisotropic segment during coalescence of its particles gathers in the adjacent isotropic segments. These appear therefore to increase in volume during contraction (Hürthle), but the apparent transfer of fluid between these regions is merely the visible expression of its displacement from the anisotropic segments by the coalescing particles within the latter. Evidently the quickness and readiness with which the transfer of fluid occurs will increase with the area of the surface separating the two regions. The disposition of the contractile material of the fibril in numerous small denser segments separated by narrower segments of looser texture (*i. e.*, with wider interstitial spaces) allows for the rapid displacement of the fluid by the colloidal particles as they coalesce; in other words, minimizes the resistance to such coalescence, and is hence a necessary condition for any rapid movement. In the reverse process of relaxation the original relative distribution of the solid and the fluid portions of the system is regained with equal readiness.

Conditions in a colloidal system of this segmented structure are thus highly favorable to rapid and promptly reversible contractile movements due to a massing or flocking of colloidal particles. The striated muscle-cell as a whole need lose no water in contraction; there is merely a temporary redistribution of the more fluid portion of the tissue within the cells. The case of the vertebrate smooth muscle fiber is different, and there is good evidence that in this tissue fluid does actually leave the cell during contraction. The characteristic slowness of both contraction and relaxation in smooth muscle may conceivably be explained on the supposition that the fluid displaced by the contraction of the intracellular fibrillar system can collect only in the relatively large intercellular spaces, *i. e.*, must pass across the plasma membrane, instead of collecting in numerous minute intracellular spaces as in striated muscle. The transfer of fluid is thus necessarily gradual, and the contraction and relaxation are correspondingly slow.

The massing of the colloidal particles in the anisotropic segments results in a shortening and thickening of these segments and hence of the whole tissue. The advantage of having all the segments of the different fibrils within the same cell equal in size and situated at the same level becomes evident on further consideration. In a system of closely crowded contractile fibrils the mechanical processes in contiguous fibrils would clearly interfere with one another were this not the case. The overflow of the displaced fluid into the isotropic segments in any fibril would be impeded, and the coalescence of the colloidal particles thus checked or prevented, if during contraction the isotropic segments were in close contact with the anisotropic segments of other fibrils; as the latter thickened they would compress the isotropic segments of the fibril under consideration, and prevent the passage of fluid into these latter. Prevention of the displacement of fluid would however retard or prevent the coalescence of the particles, and hence the whole dependent contraction. Such interference between adjacent fibrils would obviously be minimal with a parallel disposition of fibrils, such as we actually find in the tissue. This arrangement is thus mechanically the most advantageous conceivable for a tissue whose effective action depends on the simultaneous contraction of a large number of closely crowded fibrils of the above conceived structure.

We conclude therefore that the physiological advantage of both the segmented structure and the parallel arrangement of the fibrils consists in the provision thus made for a rapid to-and-fro displacement of the fluid part of the fibrils during contractile activity. This displacement of fluid is, however, to be regarded as merely incidental to the contraction, and not as its immediate cause; and in this respect the theory supported above differs fundamentally from those according to which the transfer of fluid is in itself the essential or "inogenetic" part of the process. It is of course obvious that any theory which (*e. g.*) regards contraction as due to a swelling of the isotropic segments by fluid absorbed from the anisotropic—as discs of gelatin or fibrin swell in acidulated water—must require that the interchange of fluid should be rapid and promptly reversible; hence that part of the present interpretation which regards the structure of striated muscle as essentially a means for facilitating transfer of fluid within the cell is equally consistent with this latter theory. Nevertheless the point of view that regards absorption of water by an acidulated sheet of gelatin as the analogue of what occurs in muscular contraction is radically different from that set forth in this paper, according to which the energy of contraction is the transformed surface-energy of the ultimate structural elements or colloidal particles (submicrons) composing the fibrils. There is undoubtedly a movement of fluid between the muscle-segments during contraction; but this fact in itself is consistent with either of the two theories just contrasted. The decision between the two must be made on the basis of other evidence.

Ralph S. Lillie

Marine Biological Laboratory,
Woods Hole,
June 7, 1912

FERTILIZATION OF THE EGGS OF VARIOUS INVERTEBRATES BY OX-SERUM

I

The chemical method of artificial parthenogenesis has thus far been worked out with any degree of completeness, only for the Californian sea urchin, *Strongylocentrotus purpuratus*. In this form it was shown by Loeb that the process of fertilization is composed of two entirely different phases. The one is an alteration or destruction of the surface layer of the egg. This alteration of the cortical layer may or may not result in the formation of a fertilization membrane. The alteration of the surface can be brought about by a great many different means, all of which have a cytolytic effect. The superficial cytolysis starts the development of the egg but leaves the latter with a tendency to perish during the further development. The sickly condition is remedied by a second treatment of the egg, which may consist in putting the eggs for about from 30 to 50 minutes into hypertonic sea water of a certain concentration. If taken out of this solution, the egg develops practically normally.

Experiments on heterogeneous hybridization which Loeb carried out, furnished the evidence that the spermatozoon also causes the development of the egg by carrying two agencies into it, one of which is a cytolytic substance, a lysin, which causes the membrane formation.

Lysins are contained not only in the spermatozoon but in all the cells and in the blood of any animal. Loeb found five years ago that the blood of a worm, *Dendrostoma*, calls forth membrane formation in the unfertilizing egg of the sea-urchin. This blood retained its fertilizing power when diluted as much as several hundred times with sea water.

The same author found subsequently that the blood and tissue extract of many animals had the same effect, *e. g.*, the blood of cattle. The fact that the blood of each female does not cause the parthenogenetic development of its own eggs, Loeb explained by the theory, that while the lysins contained in the blood of foreign species can diffuse with comparative ease into the egg and the cells of an animal, the lysins contained in its own blood are prevented from such a diffusion.

It was found impossible to cause the development of the eggs of all female sea-urchins by means of foreign blood. This difficulty was overcome by treating the eggs with strontium chloride before they were exposed to the foreign serum. If the sea-urchin eggs were put for a short time into a $\frac{3}{8}$ or $\frac{3}{16}$ M solution of strontium chloride, a subsequent treatment with ox blood caused them all to form fertilization membranes. When subsequently treated for a short time with hypertonic sea water, most of the eggs developed into normal plutei.

II

While in this way the mechanism of fertilization was cleared up to a large extent for the sea-urchin egg, very little had been accomplished with the eggs of other invertebrates. The eggs of a great many forms had been caused to develop by artificial means but the development was often very abnormal.

Artificial parthenogenesis was caused in the eggs of molluscs by Kostanecki as well as by Loeb, but the development was abnormal in as much as it resulted in the production of larvæ without previous segmentation. In the egg of *Cumingia*, another mollusc, efforts to produce artificial parthenogenesis had failed entirely. In annelids the results were not very satisfactory either. In *Chætopterus*, *e. g.*, Loeb produced parthenogenetic larvæ, but they developed without segmentation as he first observed and as was later ascertained beyond doubt by F. Lillie.

If the lysin theory of fertilization was correct, it was necessary to find out whether artificial parthenogenesis with an approximately normal type of development can be caused in the eggs of all animals by foreign blood. Experiments which we have carried on this year seem to indicate that this can be done to a large extent.

III

We first ascertained that the eggs of *Arbacia* behave essentially like those of *Strongylocentrotus purpuratus*. The eggs of *Arbacia* are sensitized by putting them for a short time into a $\frac{3}{8}$ *M* solution of strontium chloride. They were then exposed for about 10 minutes to ox-serum which had been rendered isotonic with sea water through the addition of sodium chloride. The eggs were then transferred for 20 minutes into hypertonic sea water. Such eggs developed normally into plutei. The only difference between the behavior of the eggs of *Arbacia* and *Strongylocentrotus* is that the eggs of *Arbacia* do not form a very distinct membrane. It is needless to say that the necessary controls were made and that we made sure that the treatment of the eggs with strontium choride or with strontium chloride and subsequently with the hypertonic solution, did not lead to the formation of embryos, although occasionally a few segmentations could be brought about in this way.

We next worked with the eggs of *Cumingia* which had been found to be refractory to the other methods of artificial parthenogenesis. We obtained an apparently perfectly normal segmentation of the eggs and the formation of larvæ, by treating them in the following way: The eggs were sensitized to the effects of serum by placing them for from 2 to 4 minutes into a $\frac{3}{8}$ *M* solution of strontium chloride. They were then placed for five minutes into ox-serum rendered isotonic with sea water and diluted with an equal part of a *M*/2 solution of $NaCl + CaCl_2 + KCl$. After having been freed from all traces of serum by repeated washing in a Ringer solution they were transferred for 60 minutes into hypertonic sea water (50 c.c. sea water + 8 c.c. $2\frac{1}{2}$ *M* NaCl). Control experiments showed that the treatment with serum is the essential factor in this process.

We induced segmentation in the eggs of *Chætopterus* by putting them for from $1\frac{1}{2}$ to $2\frac{1}{2}$ minutes into a mixture of 25 c.c. $\frac{3}{8}$ *M* strontium chloride + 25 c.c. *M*/2 NaCl + $CaCl_2$ + KCl, then for ten minutes into ox-serum diluted with its own volume of the above mentioned solution and then by putting them for thirty minutes into hypertonic sea water. From fixed and stained preparations which Dr. Bancroft made for us, we made sure that the nuclear and cell division was real and not merely apparent.

While the method needs to be perfected in some details, the experiments show that it is possible to induce, with the aid of foreign blood serum, parthenogenetic segmentation and development into larvæ, in eggs which had been found refractory to the other methods of artificial parthenogenesis. The lysin theory of fertilization is therefore more generally applicable.

Jacques Loeb,
Hardolph Wasteneys

The Rockefeller Institute,
New York,
August 12, 1912

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THE RESINS AND THEIR CHEMICAL RELATIONS TO THE TERPENES[1]

The closing years of the eighteenth and the beginning of the nineteenth centuries found chemists engaged in the study of chemical problems related to both plant and animal life. Organic chemistry during this early chemical epoch was exactly what its name implied, a study of those substances which are produced through life processes, either plant or animal. During this early epoch, the problems in plant chemistry were more inviting to the chemist than those in animal life, first, because the compounds appeared to be simpler substances and, second, because they crystallized more readily and were therefore more readily obtained in pure form. As a result of these characteristics, early organic chemistry was largely confined to plant life, consisting, however, of little more than the simple preparation of the substances themselves.

Scheele was the first to point out that the plant and animal world is made up of definite compounds, just as is the inorganic world. He proved the assertion by isolating a number of organic substances, among them tartaric, citric, malic and uric acids. He even went so far in his study of the organic compounds as to suggest what the modern physiological chemist calls metabolism, as a means of explaining certain physiological processes. Owing, however, to the extreme difficulty in obtaining physiological compounds in crystalline

[1] A part of the address of the vice-president and chairman of Section C, American Association for the Advancement of Science, Washington, December, 1912.

form, Scheele devoted much time to phytochemistry, discovering more than a score of important plant compounds besides those mentioned above. Other men followed in his footsteps and by the beginning of the last century many of the important plant compounds had been isolated.

At the very beginning of what may be justly called the renaissance in organic chemistry, Marggraf (1745–79) completed his historical work on the common beetroot. With his discovery and preparation of sucrose from the sugar-beet began the first and perhaps the greatest and most highly technical industry of modern times. It was likewise during the close of this first epoch that Pelletier began his classical work on the alkaloids, resulting in the discovery of no less than twelve of the important ones, including quinine, strychnine and brucine. In fact, it was during this same epoch that nearly all of the great families of plants were studied from the chemical point of view, resulting, in almost every case, in important discoveries. Even the resins, which chemists have until recently regarded as too complex to deserve serious attention, were studied in an industrial way and more than thirty different varieties prepared and used in the arts. But the resins were only one of the many groups of organic compounds regarded as too complex to admit of other than a study in the most general way, for organic chemistry had not advanced far enough to permit of a thorough chemical study of even the simplest of the organic substances. The adoption of the radical and the ring theories about the middle of the last century, however, completely changed the sphere of organic chemistry and synthetic methods and the chemical constitution of organic compounds became the goal toward which a large majority of chemists worked.

The adoption of the benzene ring theory, together with the working out of the chemical constitution of naphthalene, pyridine, quinoline and the terpenes, opened new fields in phytochemistry, and the first ten years of labor after the adoption of these new theories showed amazing results.

Structural and synthetic work in plant chemistry really began in the sixties. In 1869, Lieberman startled the whole chemical world by synthesizing alizarine, an important vegetable dye-stuff, and shortly after the alizarine synthesis, Baeyer succeeded in building up the indigo molecule.

Following these historical discoveries came numerous phytochemical syntheses, one of the most important being the artificial preparation of vanillin. Until Tiemann had shown that vanillin can be made cheaper in the laboratory than it can possibly be obtained from the vanilla plant, chemists, on the whole, were somewhat skeptical about the practicability of synthetic methods and especially as to the possibility of these synthetic compounds supplanting those produced by nature. The vanillin and the indigo syntheses, however, completely changed the whole chemical world in this respect. Men began to imitate nature in the building up of not only the vegetable, but also the simple animal compounds—a few enthusiasts casting longing glances at the constitutional formulæ of sugar, starch and cellulose, while the ultrachemical investigators dared even to speak in undertones of the structure of the albumins and the resins. Then came Baeyer's marvelous work on mellitic acid. His exhaustive study of this acid, which began as early as 1867, was so far reaching in its application to the ring compounds that it had much to do with final working out of the structural constitution of the terpene group.

There is a universal feeling, I think, among those who have watched the development of organic chemistry during the last twenty years, and especially along phytochemical lines, that in the not distant future all of the more important plant compounds will have been products of the laboratory. That there is ground for such a statement is borne out by what has already been done. The investigations of Loew, Butleroff, Kiliani, Emil Fischer and Wohl on the carbohydrates are so familiar to every one that it is only necessary to briefly refer to them at this time. The aldehyde condensation reaction by Loew and Butleroff, the building up of the sugars by Kiliani and the down-building by Wohl make the synthesis of the hexoses an established fact and the synthesis of the bioses at least a possibility in the near future.

The briefest phyto-synthetic review would be incomplete without referring to the most recent work of Emil Fischer and his pupils on the so-called polypeptides. Here is a group of complex substances belonging to the albumins of both the plant and the animal world, a group of compounds whose synthesis has, until recently, been regarded by many as beyond human possibility. Nevertheless, Fischer has built up the complex polypeptides until the artificial molecules are equal in size to the albumins themselves, leaving the synthesis of these complex chemical substances no longer in the list of vain possibilities.

Of scarcely less importance in the phytochemical world than the carbohydrates, the alkaloids and the albumins, are the resins and terpenes. Wallach has presented a satisfactory constitutional formula for pinene, but the resins are still classed with substances of unknown constitution. Notwithstanding the fact that less is known concerning the chemical nature of the resins than perhaps any other group of organic compounds, they are doubtless the oldest organic compounds known to man. They played an important part in the chemical industries in the early history of mankind. They were used in almost every phase of early human life, as lacs, varnishes, balsams, perfumes, pomades and in the art of embalming. They were described by the early alchemists as substances insoluble in water, generally soluble in alcohol, and for the most part non-crystallizable. They are the result of secretive plant fluids, exuding from plants and hardening in the air. They could not be separated into their constituents by any means known to the early chemists, and were therefore regarded as single substances. As a rule, however, they are mixtures of two or more complex substances, a gum and some volatile oil or terpene. They were known as gum resins or natural balsams and with the terpenes as oleoresins. As a result of their non-crystalline nature they were generally excluded from the list of substances worthy of investigation.

That there is a close chemical relationship between the resins and the terpenes, there can be no doubt, notwithstanding the fact that there is comparatively little experimental evidence to prove the assertion. One of the reasons usually given for the assumption is based on the fact that the resins and terpenes generally occur together in plants. This is by no means important evidence, for it frequently happens that entirely different groups of organic compounds are intimately associated with each other in both plant and animal life.

Notwithstanding the fact that considerable general industrial work has been done on the resins, especially those of the pine family, yet no one has been able to determine with certainty the molecular constitution of any of them, not even of abietic acid, the most common and the most important of all of the resin acids. Not only are the structural formulæ unknown, but in most cases the empirical formulæ are still in doubt. For instance, the formula for abietic acid has been generally accepted as $C_{20}H_{30}O_2$, but Mach in his dissertation on the acid gave to it the formula $C_{19}H_{28}O_2$. Absolutely nothing is known of its chemical constitution.

Various theories have been advanced concerning the relationship between the resins and terpenes. What evidence there is may be briefly stated. The fact that the aldehydes in the presence of alkalies change to resinous matter was presented by Wiesner in what may be called the reduction theory. Wiesner[2] assumed that the resins are formed from the carbohydrates, or, speaking more specifically, from the starches by a process of polymerization and reduction. It is perfectly evident that Wiesner's theory is not applicable in all cases. The pine family, for instance, contains a minimum amount of starch, yet it is the richest of the resinous species. Wiesner was aware of this fact and assumed that in the case of the pine family the resins were formed through the action of gallic and gallo-tannic acids.

While the starch theory has certain facts in its favor, there are, on the contrary, serious objections to it. It would seem not only strange, but also diametrically opposed to general chemical laws, that plants should proceed to build up the complex starch molecule and then break it down again into the resin and finally into the terpene molecule. Of course, it must not be forgotten that the sugars belong to the aldehydes and tend to form resinous substances when treated with alkalies. They are, however, by no means as readily converted into the resins as the simpler aldehydes. One would naturally expect that if the resins are formed by the aldehyde reaction they would proceed from the simple rather than from the complex aldehydes or sugars.

[2] *Centr.*, 1865, p. 756.

One of the first comprehensive works on the formation of the resins from the aldehydes was presented by Baeyer. He obtained several synthetic resins by the aldehyde condensation reaction, but an examination showed that they were unlike any of the resins found in nature. In each case the molecule seemed to be extremely complex and no attempts were made to determine the structure or the size of the molecule. Kronstein, following out the work which Baeyer had begun, presented constitutional formulæ for these aldehyde resins in a very unique but entirely empirical way. He assumed the resin molecule to be a complex benzene ring or perhaps several superimposed rings joined with either hydrocarbon, methoxyl, ethoxyl or carboxyl radicles, and gave the graphic formulæ for them. Of course such structural formulæ are interesting, but needless to say they are not based on experimental data.

In the starch explanations of the formation of the resins in plants, it must be assumed that the resins are formed by first building up the complex starch molecules from the simpler aldehydes, and then breaking them down again into the resins and terpenes. So far as can be ascertained there are no experimental data in favor of this theory. If, on the contrary, we assume that the resins are built up from the simple aldehydes, the process is more logical, as it only requires two steps, namely, polymerization and reduction, instead of three distinct steps as indicated in the following simple diagram:

$$\text{Aldehydes (Formaldehyde)} \nearrow \text{Starch} \searrow \ \text{Aldehydes} \longrightarrow \text{Resin} \longrightarrow \text{Terpenes}$$

While the above theories have many points in their favor, there is another which, while it may have some objections, has at the same time decided advantages over the starch or reduction theory.

It is common knowledge that the terpenes, when exposed to air, slowly change to complex polymers and resins of unknown composition. The principle involved is doubtless condensation followed by oxidation. Wöhler was the first to suggest that the resins may be built from the terpenes by the above-mentioned condensation and oxidation process. He based his assumption on the well-known fact that turpentine absorbs oxygen, forming a resin. This oxidation process may be represented by the following equation:

$$2C_{10}H_{16} + 3O = C_{20}H_{30}O_2 + H_2O.$$

Wöhler, unfortunately, presented no experimental data. Later, Cailliots obtained a resin by the oxidation of turpentine with nitric acid. It was not well defined, however, and not identical with any of the common resins, although it bore some semblance of common pine resin.

Barth[3] obtained, by oxidizing oil of lavender, a terpene, an amorphous resin which he carefully studied and gave the formula $C_{20}H_{30}O_3$, apparently an oxyabietic acid.

Heldt,[4] in an exhaustive study of the resins, produced common sylvic acid by oxidizing a polymerized form of turpentine according to the following equation:

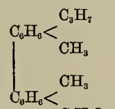
$$2(C_{10}H_{16}) \text{ or } C_{20}H_{32} + O_2 = C_{20}H_{32}O_2, \text{ sylvic acid,}$$

and

$$C_{20}H_{32}O_2 + O = C_{20}H_{30}O_2 + H_2O, \text{ or abietic acid.}$$

This work has been repeated, but without obtaining either sylvic or abietic acids.

One of the most interesting communications along this line was presented by Bruylaut. He obtained, by a method not given, a polymer of pinene which he represented as a condensation of two molecules of pinene or dipinene. By oxidizing this substance he obtained an acid which had the empirical formula for abietic acid:



No details of the work, however, were given.

Work on the condensation of the terpenes has been in progress at the University of Minnesota for several years. Before describing some of these experiments, however, it may be of interest to briefly trace the work on the synthesis of the terpenes themselves. It was observed early in this work that when pinacone is treated with bromine, an extremely complex reaction takes place and among the products formed are isopropyl alcohol and substances belonging to the terpenes. It was found, however, on carefully studying the reaction, that Baeyer had already observed this fact, but had not followed out the reaction, doubtless on account of the extreme complexity of the reaction. If, however, we take into consideration these two substances, the reaction may be represented as follows:

$$6C_6H_{14}O_2 = 2C_3H_8O + 3C_{10}H_{16} + 10H_2O.$$

Some time previous to this work, Kondakow[5] in his work on angelic and tiglic acids obtained from them a hydrocarbon which proved to be a methyl derivative of crotonylene. It had the general formula for the hemiterpenes. From the description it seems quite likely that this hydrocarbon is related to the terpenes, for it has the formula $CH_3{=}C(CH_3){-}CH{=}CH_2$, which is

[3] *Ann.*, 143–313.

[4] *Ann.*, 63–48.

[5] *Jour. of the Russ. Phys. Chem. Soc.*, 1891, I., 178.

identical with the hemiterpene, isoprene.[6] Now, angelic and tiglic acids are comparatively common in the plant world and if, as Kondakow states, these hydrocarbons are readily obtained from the acids, then it is possible that the hemiterpenes are formed in this way and by the condensation of two molecules of the hemiterpenes, a terpene in this particular case, camphene, is formed according to the following simple equation:

$$2C_5H_8 = C_{10}H_{16}.$$

In pursuing the work of the terpene polymerization, practically all of the methods in the terpene literature were tried. All of them, however, were unsatisfactory. It was noticed in previous work on the chlorhydrochlorides[7] of terpenes, that in the preparation of the hydrochloride on a large scale there was always left a considerable portion of material of thick oil consistency after the chloride had been removed. Examination showed that this oil contained a small quantity of resinous matter. After unsatisfactory attempts to isolate the resin, other agents were tried. Bromine and iodine were tried and each was found to produce resins more readily than chlorine. As iodine gave best results, it was used in the experimental work which follows. It was found, first of all, that iodides somewhat similar to the chlorhydrochlorides could be formed, especially if the reaction took place in sunlight. These iodides were first isolated and studied. The diiodide proved to be of special interest. When pure it is a heavy colorless oil with a slight camphoraceous odor. When exposed to sunlight it readily decomposes, liberating iodine and resins, notwithstanding the fact that sunlight seems to play an important part in its formation. If exposed to sunlight for some time the iodine is all liberated and there is left a resinous mass composed chiefly of two substances. This resinous mass was subjected to distillation in vacuo. The distillate obtained was a thick, colorless, stable oil. Its molecular weight indicated a dipinene. It contained no iodine, and from its remarkable stability it is probable that the pinene radicles are doubly joined to each other. By oxidation it forms an acid isomeric with abietic acid. The residue left in the flask after the dipinene had been removed was also of unusual interest. It proved to be a solid of a light amber color. It had exactly the same melting point of ordinary rosin. Most of its properties were also identical with those of common rosin. It proved to be a tetra pinene, and, owing to its close resemblance to ordinary colophonium, it has been called colophonene.

These two condensed forms, the di- and the tetra-pinene compounds, have been isolated and carefully studied. Both are stable, but may be oxidized to acids with many of the characteristics of the resin acids. A comparison of these synthetic compounds with the natural resins is both interesting and important. Those which have been prepared and examined at the present time do not agree in every respect with the natural resin acids. This fact is not surprising, however, as any one of the different groups, occurring in the molecule when oxidized, would give a different acid. It would, therefore, be mere chance if the synthetic compounds should be identical with the common resin acid.

In summing up the experimental evidence in connection with the theories of the formation of the resins and terpenes and their chemical relationship, the following syntheses may, under different conditions, represent what takes place in certain phases of plant life:

[6] It may be interesting to the reader to note that isoprene has very recently been polymerized to india rubber.

[7] *Jour. Am. Chem. Soc.*, 28, p. 1461.

1. The formation of the resins from the simple aldehydes.

2. The formation of the resins from the complex aldehydes or carbohydrates.

3. The formation of the resins from the terpenes.

It is not impossible that the resins are formed by any one of the above syntheses. There are abundant reasons for believing, however, that the synthesis of many of the resins is intimately related to the terpenes, that is, the terpenes may be first formed from simple compounds as the hemiterpenes, then converted into the resins by condensation and oxidation. This reaction seems entirely in accord with the chemical changes which naturally take place as phytochemical changes usually proceed from the simple to the more complex, as for example, from formaldehyde to the carbohydrates, but never from the carbohydrates to formaldehyde.

From the study of these terpene derivatives, it seems more than probable that the resins, at least those on the pine family, bear the same general relationship to the terpenes that naphthalene does to benzene and that the terpene molecule, $C_{10}H_{16}$, is the common substance from which the resins are derived.

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THE METAPHOR IN SCIENCE

There are several examples in the history of science where an idea at first represented by some metaphorical expression became in course of time a concrete existence. Most of the sciences have instances of it; one meets first with a notion, often of the vaguest, a principle, a property, a potentiality for something or other, and one ends with a substance, a species of matter, tangible and ponderable: the notion has become incarnated.

Inorganic chemistry offers us an excellent case of this sort of thing. When Lavoisier was working out the character of the substance we now know as oxygen, he had not isolated oxygen by a stroke of genius and then proceeded to study the properties of the new chemical product; the history of its discovery was far otherwise. Acting on some hints given him in October, 1774, by Joseph Priestley, Lavoisier came upon what he soon named as the "principle of acids" or "the acidifying principle"; his words are (1777):

> I shall therefore designate dephlogisticated air, air eminently respirable, when in a state of combination or fixedness by the name of acidifying principle or if one prefers the same meaning in a Greek dress by that of *oxygine principle.*

Here it is a principle, something which combines with metals when they are calcined or burned in air; it is that something which to Lavoisier seemed essential in acids, that which produced acidity, the oxygine principle. In its later and more familiar form of oxygen, it is better etymologically. That which was a principle in 1777 was about 120 years afterwards a visible, tangible entity—the liquefied, steel-blue oxygen gas. The principle of 1777 by 1897 had become a substance; the metaphor had become an actuality.

Not all chemical concepts have been equally fortunate in leading to true and individual chemical substances: phlogiston, for instance, denoting, as it did, no reality, is the conception phlogiston still. The principle of heat, phlogiston, was supposed to leave a body when it was burned: the theory of Stahl asserted that heat was a thing, a thing which could depart from a body and leave it lighter than before when it was cold. Now this, as a conception, is sufficiently definite, but as it is not true in fact, phlogiston never materialized; it was never isolated from matter because it never existed in matter. Phlogiston was as barren a conception as "oxygine" was pregnant. To-day Priestley and Lavoisier could be presented with an ounce or so of the "oxygine" principle, but not a milligram of phlogiston could be extracted for Stahl, for oxygen is a substance, but heat is a mode of motion. Probably the most pregnant metaphor ever used in science was Harvey's as regards the movement of the blood—"motion as it were in a circle." This phrase was of course written in Latin as "an motionem quandam quasi in circulo haberet"; it forms part of the sentence thus translated:

I began to think whether there might not be motion (or a movement), as it were, in a circle. Now this I afterwards found to be true.

Later in the same chapter (VIII. of the "De Motu") he writes:

This motion we may be allowed to call circular (Quem motum circularem eo pacto nominare licet.)

The establishing of the fact of the circulation of the blood was absolutely essential to the creation of physiology; modern physiology has, indeed, arisen from this one fact, and the fact received its name—circulation—from the well-chosen phrase "circular motion." The phrases "circle" and "circular" of 1628 became in due time part of the language of physiology; and the circulation of the blood which was a phrase and an inference in 1628 became a visible demonstration in 1660. For it is a fact, one of the most pathetic facts in the history of biology, that Harvey died without ever having seen the blood moving as he knew so well it did, for he died in 1657, three years before Marcellus Malpighius—the man born in the year the "De Motu" was, 1628—saw the blood of the living capillaries of the transparent lung of the frog. Thirty-two years separated the metaphor from the demonstration, the prophecy from the fulfilment. Had Harvey lived three years longer, he could have seen with his own eyes that what he had prophesied was correct, he could have been shown as an actuality what his reason had discovered as a magnificent inference, the most magnificent inference ever made in the realm of the living.

The next example we may take from physiological chemistry and from that new department of it called "internal secretion." Until comparatively recently, the function of the two small yellow bodies situated near or on the kidneys—adrenals or suprarenals—was entirely unknown and barely even speculated upon. In 1855 Dr. Addison, of Guy's Hospital, London, described a disease, since named after him, in which the patient suffered from extreme weakness both of muscles and of heart, and after death was found to have had his suprarenal bodies degenerated usually through a tubercular lesion. Physiologists very properly assumed that the explanation of this was that in health the suprarenal bodies produced something which, gaining access to the blood, was carried to all parts of the body and maintained the efficiency or tone of the body-muscles and those of the heart and blood-vessels as well. This something was apparently absent from the blood in Addison's disease. This something remained undiscovered until 1895, when watery extracts of the suprarenals were made and injected into the veins of a living animal. The result of this was a surprising increase in the tone of the animal's heart and small arteries so that its blood-pressure rose greatly. Something was clearly contained in the suprarenal extract which had powerful physiological effects: let it be called "adrenalin." But it is one thing to name a hypothetical substance and another thing to isolate a real one. In this case, however, the hypothetical substance was a real one, so that after some years of work between 1897 and 1904, the physiological chemists succeeded in separating from the glands a substance in a state of purity which had all the properties possessed by an extract of the suprarenals. Adrenalin was for the first time isolated about forty-five years after its existence had been surmised. So perfectly had the chemical something that maintains the tone of heart and blood-vessels been isolated, that its constitution became so well known that the final triumph of making adrenalin synthetically was not long delayed. In 1904 it was made synthetically in Germany, and in the following year in England, so that within fifty years of its suspected existence, adrenalin, with all the properties of the natural material, was seen and handled as a pure, crystalline chemical substance of composition so well known that its structural formula could be written and a name denoting it laid before those capable of understanding it (di-oxyphenol-methyl-aminoethanol). Here we have literally the materialization of a chemical idea, the crystallization of a notion; the thing of the mind has become a thing of the laboratory, the thought has been captured and bottled.

The next "as it were" we shall take from the history of the physiology of the central nervous system in the writings of a pupil of Harvey, Dr. Thomas Willis. At the present day the name and the process "reflex action" is as well established as is anything in animal behavior. One of the most certain things in the physiology of the nervous system is that if we stimulate a nerve going into it, we shall produce outgoing effects, muscular contractions, vascular or glandular changes. If we decapitate a frog and hang up the body and apply a piece of acid paper to one flank, the leg of that side will be brought up to flick it off, and if the acid be very strong the whole frog will be thrown into convulsions—these movements are reflex actions. Now this very definite physiological conception of a reflex neural action arose in a metaphor, in an "as it were" of Willis penned about 1650. He said:

> We may admit that the impression of an object driving the animal spirits inwards and modifying them in a certain peculiar manner, gives rise to sensation and that the same animal spirits, in that they rebound from within outwards in a reflected wave as it were, call forth local movements.

Willis's notion was that of a wave reflected back towards its source, but the metaphor about nerve impulses being reflected evidently represented the truth, for it has lived on and become an integral part of the terminology of neural activity. If there had been no germ of accurate description in it, the idea contained in the metaphorical phrase "as it were reflected," would not have survived to our own day; but it has lived to become the definite description of a fundamental neural truth.

Dr. Marshall Hall, who did so much for the physiology of this sort of action, adopted the phrase and incorporated it in one of his own—the "reflex nerve-arc" which denotes the anatomical path over which reflected nerve-impulses travel. If Willis could visit our laboratories to-day, we could show him reflex actions performed with automatic precision, and below the microscope we could let him see the various links in a reflex nerve-arc. He would find his "as it were reflected" no longer taken in a metaphorical sense, but used as the most appropriate mode of denoting one of the commonest and most important of neural activities.

The study of nerve-impulses gives us another example of the inevitable tendency towards concreteness and definiteness in notions regarding the behavior of the central nervous system. If we go sufficiently far back, we find the Greeks, for instance, imagining that the nerve fibers conveyed spirits through their pores (poroi). No doubt these spirits of antiquity are the synonym of our "nerve-impulses," something propagated with considerable rapidity from one end of a nerve to the other. Still for ages that something was quite unapproachable on the part of the senses. Some physiologists imagined that the muscles became active because the spirits of the nerves rushed into them, but Borelli (1670) on cutting open living muscles under water could see no bubbling of gas or anything else suggesting them to be inflated with any kind of substance—spirit, flatus, succus nerveus or gas. But it is to his credit that Borelli looked for something of the kind; he desired to render the succus nerveus concrete, to see the action of the spirits in the nerves, if possible. It was not to be; for nerve-impulses are a mode of motion and only to be discovered through their effects. In our own day, one evidence of their passage along nerves, namely, the electrical, has been made sufficiently obvious by that exquisite instrument the galvanometer. By the aid of this very delicate apparatus, the electric currents produced by the nerve impulses can be made to swing a mirror reflecting a beam of light on to a screen, it may be, several feet away. Although nerve-impulses are no more visible to-day than were the nerve spirits of the Greeks or was the succus nerveus of Borelli, we are in a position to show these thinkers of the past a spot of light jerked two or three feet to the right or left of its resting position through the instrumentality of an electric current generated by a single nerve-impulse whose electromotive force is not greater than 0.015 of a volt. We have not rendered nerve impulses evident to sight, but we have measured the electromotive force of their electrical manifestations as accurately as we measure the rise of temperature caused by minute quantities of heat.

We need not be surprised to be told that it was universally believed that nerve-impulses traveled with incalculable speed, that a flash of thought and a flash of lightning were both prodigiously rapid. In 1850 Professor Helmholtz measured the velocity of the nerve-impulse, and ascertained it to be about 40 meters a second in the nerves of man. Thus the movements of the spirits, once thought so erratic, have been measured; the intangible is still intangible, but the immaterial has been found to be in material and as such to be as real as the material, neither more nor less so.

Of late years there has been a very distinct tendency towards concreteness in regard to ideas of nerve-force and its diminution in fatigue and in disease. At one time nerve-force seemed to be the special property of the quack and the charlatan, but the microscope which has solved so many problems for us has shed its light also on this most elusive subject. A substance has been discovered in the interior of nerve-cells which is found to accumulate as the cell rests and to be worn away the longer the cell has been active. The substance takes the form of minute granules or prisms called after their German discoverer the granules of Nissl. The nerve-cells innervating the wing muscles of a sparrow have been examined in the early morning before the bird has begun to fly about, and similar cells have been scrutinized in a wholly similar bird after a long day of activity; on comparing these two sets of cells under the microscope, the thing wherein they were found to differ was the quantity and appearance of the granules of Nissl. Since these granules tend to disappear when nerve cells are active, and to reconstitute themselves when nerve cells rest, they are evidently to be regarded as the physical basis of nerve energy, the local seat of the processes concerned in the output and in the restoration of nerve energy.

It is clear, then, that the granules of Nissl with the evolution of nerve energy and may be called the dynamogenic material which is widely distributed throughout the nervous system. But it follows from this that fatigue, in so far as it has a microscopical basis, will be denoted by the more or less complete disintegration of the granules. Fatigue, which as understood by most people is merely a particular kind of feeling or sensation, has been shown to produce a cognizable change in some physical structure; in other words, it has been made concrete. General fatigue on its objective side has now been proved to be a condition of bodily poisoning. The prolonged activity of muscles and other tissues results in the output of certain chemical materials (fatigue-toxins) which, circulating in the blood, produce a mild poisoning, one of the effects of which is to depress the activity of the cells of the central nervous system, the objective sign of which is well known to be the partial solution of the granules of Nissl. Thus such comparatively indefinite and illusive things as nerve force and fatigue have by the microscopists and chemists of our time been identified and shown to have a local habitation and a general distribution respectively in the minute recesses of the living material of the body. The whole tendency here has been towards the objectifying of the subjective and the visibility of the unseen.

But of course it is very largely in the sphere of the healing art that this modern tendency towards concreteness is to be seen in its highest perfection. Let us take the case of malaria or ague, a disease the cause of which not so very long ago was absolutely unknown. Not that it was not attributed to causes such as "paludism," "telluric influences," exhalations, vapors, and so on, but these did not explain anything. The word malaria is of course derived from two Italian words meaning "bad air" clearly showing that the atmosphere was held to be responsible for some peculiar kind of corruption or infection as we should now call it. Paludism, the influence of marshes, could not be seen; what could be seen were fogs or vapors rising from the marshy ground and these were blamed for spreading malaria, and people were told to beware of the damp and of night air. But why vapor, whether in the daytime or at night, should breed any kind of disease, most of all so definite a disease as ague, was not at all obvious. At last all these vaguenesses were dispelled, and malaria was discovered (1880) to belong to that already large group of diseases known as parasitic, only the parasite in this case was an animal and not a vegetable. Ague was found to be due to the destruction of the red blood-corpuscles by their having been made the residence of a minute animal parasite, the *Plasmodium malariæ,* which had been inoculated into the patient through his having been bitten by a particular kind of gnat or mosquito (*Anopheles*) which had sucked blood from some one suffering from malaria. It was not contagion, nor ordinary infection, far less bad air or vapors or exhalations, it was natural, accidental inoculation with foreign blood containing excessively minute living creatures classed by zoologists as a species of Protozoa.

Thus the connection of malaria with marshes and vapors and night-time was at once explained by the facts that the mosquito lays its eggs in damp places and frequents damp places towards evening and after dark. The meaning of the usefulness of quinine is explained by its being able to kill the parasite in the blood; it is only a local, circulating germicide. Thus the microscopist has tracked down one of mankind's subtlest foes, found it neither mist nor marsh, vapor nor corruption, but a moving, living creature, a member of the lowest group of such known. The vagueness has gone; the cause of malaria can be viewed sealed up in Canada balsam under a cover-glass.

Another excellent example of the rendering definite what was before of the vaguest is the recent discovery of the cause of plague, the pestilence, or Black Death. In the fourteenth century the great surgeon of Avignon, Guy de Chauliac, attributed the plague to a conjunction of the planets Saturn, Jupiter and Mars in the sign of Aquarius on the twenty-fourth of March, 1345. About the same time the Jews in Germany and Switzerland were suspected of poisoning the wells, and were in consequence persecuted and massacred. In the fourteenth century the medical faculty of the University of Paris was asked to deliver an opinion on the nature and origin of plague, but a very great deal that it promulgated was absolutely fatuous as regards protection or cure. One thing only was recommended that is interesting in the light of to-day, namely, the fumigation of houses by the burning of aromatic herbs and woods. Only as recently as 1894 was the vera causâ of the Black Death, one of mankind's most terrible traditions, discovered by two Japanese doctors, Yersin and Kitasato, and named the *Bacillus pestis.* It was soon isolated in pure cultures and grown in artificial media, and its toxins and antitoxins became chemical entities.

The history of the discovery of what plague is really due to is a strange, eventful history. The Black Death, that most dreadful scourge of mysterious origin, was for centuries attributed to such sources as the conjunction of planets, the iniquities of the Jews or to some special outpouring of divine wrath on account of human sin. Mankind, utterly at a loss to discover its true relationships, had for millennia imagined vain things, and essayed the most grotesque methods of averting it. But in the fullness of time the microscope was devised and with it the dawn of the day of exact knowledge had arrived.

The source of plague was shown to be a bacillus, a most minute, vegetable parasite which, growing in bodies of certain animals, rats and other rodents, could give rise to a most virulent poison (pestiferin) which was carried to all parts by the circulating blood. It was further shown that man became inoculated by fleas which had been feeding on the bacilli-containing blood of rats; and thus were revealed the several links in that long chain which had the *Bacillus pestis* at one end and man at the other. It took mankind 3,000 years to come to a knowledge of the truth regarding the cause and manner of spreading of plague, to a knowledge of that chain of cause and effect which connects microbe and man in the dire relationship of the plague-stricken.

Science, then, has come face to face with the specter of the Black Death and recognized its features. She has laid hold of "the pestilence that walketh in darkness" and made it reveal its horrid origin.

Similarly for influenza, a disease in its epidemic form, if not quite so deadly as plague, then quite as mysterious; in some forms quite as deadly. Very probably some of the great epidemics of the middle ages were in reality what we now call influenza, its very name being only the Italian for influence—a something inscrutable but omnipresent, mysterious in the last degree. The usual expressions were in vogue, it was a corruption in the air, a miasm, an exhalation and so on; until in 1892 the bacteriologist Pfeiffer isolated the organism of influenza and named it the *Bacillus Influenzæ*. Not the air, then, but the microscopic fungi it may hold for evil influence, is the true cause of influenza. The influence is now materialized, nay indeed is isolated and sealed down under glass for the inspection of trained eyes. Thus by the microscope are these deadly powers of the air one by one distinguished from each other and identified each in its particular malignancy.

No better example than that of the ferments could be given of a notion becoming in course of time a substance isolated and tangible. Fermentation, the totality of changes produced in digestible, coagulable or putrescible material, was for ages believed to be inscrutably mysterious. It was made the subject of debate between the iatro-mathematicians and the iatro-chemists of the seventeenth century, but neither school really understood it.

Digestion, the great fermentative process in animals, was confused not only with putrefaction, but with boiling and with the effervesence of gas in chemical operations. Stahl saw in digestion the direct activity of the soul or anima which, he held, permeated every tissue and endowed it with its special powers. The chemistry of it all, however, was unknown: the very conception of a ferment—a substance produced by living matter but not itself living—had not as yet emerged from the mental confusion.

Van Helmont (1577–1644), Sylvius (1614–1672), De Graaf (1641–1672), Haller (1708–1777), all groped for it, but it was not until through the work of Réne Antoine Ferchault de Réamur (1750) that any true idea was held as to the nature of fermentation in digestion. Réamur was the first to obtain gastric juice in an approximately pure state and to attempt digestion with it outside the body. Spallanzani, the distinguished Italian naturalist at Pavia, began where Réamur left off, and soon discovered that digestion was by no means putrefactive but was apparently due to some "solvent power" or "active principle of solution" in the gastric juice (1777). Then by degrees as physiological chemistry improved its methods, it got finer results, and at last "the solvent power" or "principle of solution" in the gastric juice was isolated in 1862 as the white powder, pepsin, a name which had been given to the active principle by Schwann as far back as 1836. Soon other ferments were either isolated or obtained in solution, and to-day in our laboratories we store in glass bottles half a dozen or more of the actual substances which are the modern representatives of the "principles of solution" of the early researchers. The vague has become definite, the conceptual power or property has become the material substance or entity.

The story of the discovery of the telescope, how it was bound up with that wonderful emancipation of the human spirit from the thraldom of mediæval ignorance and the hatred of scientific light, has been told us by many learned men; but I venture to think that the discovery of the microscope, which has never yet had its historian or poet, was one fraught with many more beneficent results for humanity. By its scrutiny the invisible but actual sources of most of the scourges of mankind have been discovered; and it would seem that it is in its power and not in that of fleets or armies that we must look for the physical salvation of the sons of men. Man may redeem himself from death, not by sweeping the heavens with the space-annihilating telescope, but by peering into the dust of the earth with the space-creating microscope.

We see then that the principle of the incarnation of ideas, of the realization in the world of substance of what had been vaguely foreshadowed in the world of mind, is a process which has gone on in science as surely but perhaps not so conspicuously as it has in art. The artist succeeds more or less perfectly to incarnate his ideas of beauty in stone, in wood, in metal or in pigment, but no painter ever yet expressed all the loveliness in his mind, pellucid though his pigments were; the poet strives to give utterance to the majesty of his imagination, but no poet was ever yet satisfied that his words, choice though they were, portrayed all the delicacy of his fancy or the glory of his dreams. The musician is conscious that after he has swept the lyre with melodies of transcendent sweetness, there are unheard melodies that are sweeter still; the preacher whose eloquence stirs the vast cathedral returns home depressed in that his burning words did not rise to the fever-height of his fervor. The saint, aiming at the highest ideals of holiness, has still to confess failure whether as anchorite, prophet, missioner or philanthropist.

But it is sometimes given to the man of science to touch, to taste, to handle what was once only a notion, a suggestion, a forecast either in his own day or in that of a less fortunate predecessor in the earlier times of the history of a thought.

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A NEW FRENCH CAVERN WITH PALEOLITHIC MURAL ENGRAVINGS

To Count Begouen, of Toulouse, and his two sons, belongs the credit for the discovery of a new cavern with paleolithic mural engravings. The eldest son, Max, is at present a pupil of Professor Emile Cartailhac, as was his father before him. Count Begonen, with his family, is spending the summer at his country place, "Les Espas," at Montesquieu-Avantès, near St. Girons (Ariège). On property adjoining his is the cavern of Enlène known for many years and where the count himself recently discovered a finely carved spear-thrower of reindeer horn. Near Enlène the Volp, a small stream, disappears under a ridge of limestone and reappears about one kilometer farther down. The escarpment where the Volp reappears has long been known as the Tuc d'Audoubert. After improvising a small canoe made of a box and given stability by a float on either side—a keg and an oil can, on Saturday, July 20, Count Begouen and his sons ascended the channel for about 50 meters, as far as the present level of the water would permit of rowing. By bridging with ladders at intervals they ascended on foot much farther and then climbed to the entrance to a cavern on the left. This led to a series of large chambers remarkable for the quantity as well as beauty of the stalagmite and stalactite formations. Luckily these had not been despoiled by the hand of the tourist. Only two or three times did the party of four find evidence that they were not the first to behold these wonderful art products of nature. At one point a name with the date 1689; at another a name and the date 1701. After traversing a number of galleries they at last came to a small corridor near the end of which they saw a small pit which appeared to have been recently dug in a search for artifacts. The disappointment on finding the pit indicating that another archeologist had been there before was not of long duration, for on looking up they beheld simultaneously a number of animal forms delicately incised on the sloping walls, some of them surrounded by thick layers of stalagmite, others partially hid by the same. The figures include about half a dozen horses, nearly as many bison, one reindeer, one bovine animal and some ten curious signs, probably a weapon. One of the horses is represented as being caught in a trap, others as being struck by arrows. The figure of the reindeer is of special importance because of its rarity as a mural ornament in the Pyrenean caverns.

On the day of the discovery of the parietal engravings in the cavern of Tuc d'Audoubert, I was leaving the cavern region of northern Spain for Toulouse to join Professor Henry Fairfield Osborn, of the American Museum of Natural History, in a tour of the French Pyrenean caverns under the guidance of Professor Cartailhac, to whom Count Begouen telegraphed news of the find. Professor Cartailhac was able to add this new cavern to our itinerary. We reached "Les Espas" on July 25 in time for luncheon, after which Count Begouen and his sons conducted us to the cavern of Tuc d'Audoubert. Although they had been to the cavern every day since the discovery in a search for more parietal art, certain examples remained to be either discovered or interpreted on the day of our visit. Near the entrance to the corridor previously mentioned Count Begouen found an additional engraving of the horse. Some incisions discovered on one of the previous days, the trained eye of Professor Cartailhac made out to be a figure of *Elephas primigenius*. On a projecting rock two spots of red paint had been seen on a previous day but to my satisfaction it remained for me to be the first to recognize them as two eyes, the projecting rock being an animal head in the round. The paleolithic artist was quick to take advantage of fortuitous resemblances in arriving at results that would otherwise require much time and labor as exemplified not only in this latest find but also in previous ones, for instance, at Niaux, Altamira and Castillo.

Tuc d'Audoubert is the most beautiful cavern in southern France. Fortunately it is in appreciative hands, for Count Begouen is mayor of the commune (Montesquieu-Avantès) in which it is situated. He will take immediate steps to protect its treasures of ancient art and of nature from vandalism. He and his son Max will also prepare a report fully illustrated, which is to appear in the monumental series published under the auspices of the Institut de Paléontologie Humaine, Paris. The importance of the find and the fact that two Americans took at least a small part in the first few days of exploration justify me in sending at the earliest possible moment this short notice to Science.

George Grant MacCurdy

Toulouse,
July 27, 1912

INTERNATIONAL CONGRESS OF ENTOMOLOGY

The second International Congress of Entomology met at Oxford at the beginning of August under the presidency of Professor E. B. Poulton, F.R.S., Hope professor of zoology. According to the report in the London *Times* Professor Poulton in his address paid special attention to the processes by which a species by natural selection seeks to maintain its place in the insect cosmos. Other papers upon evolution, bionomics and mimicry were contributed by the president, who gave an account of Mr. C. A. Wiggin's and Dr. G. H. Carpenter's researches in mimicry in the forest butterflies of Uganda; by the Rev. K. St. A. Rogers and by Mr. R. C. L. Perkins, who described and compared the color-groups of Hawaiian *Odynerus* (wasps) found on the two neighboring islands, Oahu and Kauai. In the section of philosophic entomology Professor J. F. Van Bemmelen (Netherlands) explained the phylogenetic significance of the development of the butterfly wing.

In the section of economic entomology the paper read by Sir Daniel Morris on behalf of Mr. W. A. Ballou, "Some Entomological Problems in the West Indies," demonstrated how an intimate knowledge of the life histories of insects may be put to practical uses, and how by the introduction of the natural parasite of an immigrant pest the attacks of the pest may be controlled and even defeated altogether. The question of international action to check generally the importation of pests was raised in the discussion of Mr. A. G. L. Rogers's paper on "The necessary investigation with relation to Insect and Fungus Enemies of Plants, Preliminary to Legislation."

In the pathological department Professor

S. A. Forbes, of the University of Illinois, contributed a series of observations on "*Simulium* and Pellagra in Illinois, U. S. A." He has failed to associate directly the many cases of pelagra investigated with insects of this genus.

The congress decided to institute an international committee to deal with the subject of entomological nomenclature, and advised the formation of national committees in each country, to be elected by the various entomological societies, to collect opinions and consider changes required in the international code; and further commissioned the international committee to communicate their resolutions to the international committee on zoological nomenclature.

The third international congress will be held at Vienna in 1915, under the presidency of Dr. A. Handlirsch.

SCIENTIFIC NOTES AND NEWS

Dr. Wilhelm Wundt, professor of philosophy in the University of Leipzig, one of the founders of modern psychology, celebrated his eightieth birthday on August 16, on which occasion a "Wilhelm Wundt Stiftung," amounting to 7,000 Marks, was presented to the university by his students and friends.

The students, colleagues and friends of the late Professor Thomas H. Montgomery are desirous of purchasing his zoological library and presenting it to the University of Pennsylvania in grateful recognition of his services and achievements. It is proposed to mark each volume with a book-plate indicating that it forms part of The Montgomery Memorial Library. Contributions towards the purchase of the library may be sent to Dr. H. G. Kribs, treasurer, Zoological Laboratory, University of Pennsylvania, Philadelphia, Pa.

Dr. Charles L. Parsons, secretary of the American Chemical Society, will move to Washington on September 1, and the main office of the American Chemical Society will be in that city after the date mentioned, with address as Box 505, Washington, D. C.

The International Lenval prize of the Otological Congress has been awarded to Dr. George E. Shambaugh, Chicago, for his work on the anatomy and physiology of the labyrinth.

Dr. Hans Winkler, associate professor of botany at Tübingen, has been appointed director of the Botanical Institute at Hamburg.

Dr. Hermann Kredner, professor of geology and paleontology at Leipzig, has retired from active service.

Dr. Alexander Naumann, professor of chemistry at Giessen and since 1882 director of the chemical laboratories, celebrated his seventy-fifth birthday on July 31.

Professor George Grant MacCurdy, of Yale University, has been appointed the representative of the American Museum of Natural History at the eighth session of the Congrès Préhistorique de France, at Angoulême, August 18–24. He will also represent the museum at the fourteenth session of the Congrès International d'Anthropologie et d'Archéologie préhistoriques, to be held at Geneva the first week in September.

Professor Herbert E. Gregory, head of the department of geology in Yale University, has sailed for Peru to join the Yale Peruvian expedition under Professor Hiram Bingham. They expect to return at Christmas time.

The resignation of Professor Sarah F. Whiting, who founded the department of physics at Wellesley College and has been its head ever since, has been accepted by the trustees, and Miss Louise Sherwood McDowell, Ph.D. (Cornell), has been appointed her successor. Professor Whiting was the first woman student in physics at the Massachusetts Institute of Technology, where Professor E. C. Pickering had lately started a students' laboratory. She opened the laboratories at Wellesley in 1878, thus antedating most student laboratories in American colleges. Courses in the new astronomy were offered as applied physics until Professor Whiting secured the funds to build an observatory with an exceptional equipment. For ten years she has had charge of both departments. She continues in charge of the department of astronomy.

There has been published in Science a list of the foreign geographers taking part in the transcontinental excursion arranged by the American Geographical Society of New York. A considerable number of American geographers accompany the excursion, either for portions of the distance or for the entire trip. Those who make the entire trip, in addition to the director of the excursion, Professor William M. Davis, of Harvard University, are: Albert Perry Brigham, professor of geology, Colgate University; Richard E. Dodge, professor of geography, Teachers College, Columbia University; Nevin M. Fenneman, professor of geology, University of Cincinnati; William J. Humphreys, professor of meteorological physics, Weather Bureau, Washington; Mark Jefferson, professor of geography, State Normal College, Ypsilanti; Lawrence Martin, assistant professor of physiography, University of Wisconsin; Robert DeC. Ward, professor of climatology, Harvard University, and Frank E. Williams, instructor in geology, University of Wisconsin.

Professor Hugo de Vries will visit this country again in September and October next. His itinerary, so far as can be arranged in advance, is to reach New York about September 12, where he is to give a lecture at the Botanical Garden on September 14. From there he goes to the University of Pennsylvania to see the work which Professor Davis is doing with *Œnotheras*, and will then spend a short time in Washington. His next objective point will be Dixie Landing, Ala., where he goes with Professor Tracy to visit the type locality of *Œnothera grandiflora* to study its possible mutants in its original habitat. He will then go to Biloxi, Miss., where he will make his headquarters while he visits the "mud lumps" near the mouth of the Mississippi River, and a number of the islands near Biloxi. After that he and Professor Tracy will go to San Antonio, Brownsville and other points in southern Texas, where Professor de Vries goes to study the relations of the flora to the geological and geographical conditions. On October 14, Professor de Vries is to deliver the dedicatory address of the Rice Institute, at Houston, Texas.

Professor Rollin D. Salisbury, head of the department of geography and dean of the Ogden Graduate School of Science in the University of Chicago, has been granted leave of absence during the autumn quarter for the purpose of scientific investigations in South America. Professor Salisbury, in company with Mr. Bailey Willis, of the U. S. Geological Survey, sailed from New York on August 10 for Panama, whence they cross the isthmus and go down the west coast of South America as far as Valparaiso, Chile. A few days will be spent on the west side of the Andes, with a possible trip southward as far as the railroad will carry them in Chile, and the party will then cross the range by the Trans-Andean Railway, going into northern Argentina and then down to Buenos Aires. About October 1 Professor Salisbury intends to camp in Patagonia at Lake Nahuel Haupi in the eastern Andes in latitude 41°. On his return he expects to stop at Rio de Janeiro and go back into the interior from that point to the great iron deposits of Brazil.

The American Museum of Natural History has received a telegram from V. Stefanson, who has been conducting an ethnological and zoological expedition in the Coppermine River region and adjacent islands in the Arctic Ocean. This telegram is dated August 18, and was sent by way of the revenue cutter *Bear* to Nome and thence to Seattle. It says that Mr. Stefansson arrived at Point Barrow, Alaska, on June 13. He reports that he devoted the winter to studies of the linguistics of the Eskimo and the summer to the excavation of ancient village sites. He has some 50,000 archeological specimens. On this expedition he was accompanied by Dr. R. M. Anderson. Mr. Stefanson reports that Anderson and the eastern collections, that is collections from the Coppermine River region, will be due in San Francisco next November.

J. J. Taubenhaus, assistant plant pathologist of the Delaware College Agricultural Experiment Station, delivered an address on July 14, 1912, on "Our Present Knowledge of the Sweet Pea Diseases and Their Control," before the American Sweet Pea Society which held its annual exhibit in the Horticultural Hall of Boston, Mass.

At the eighty-fourth convocation of the University of Chicago, which will be held on August 30, the convocation orator, Dr. Henry Churchill King, president of Oberlin College, will have for his subject "The Contribution of Modern Science to Ideal Interests."

William S. Weedon, Ph.D. (Hopkins), since 1904 research chemist for the E. I. du Pont de Nemours Powder Co., died in Wilmington, Del., on July 10, aged thirty-five years.

Mr. Robert Holford Macdowall Bosanquet, F.R.S., fellow of St. John's College, Oxford, known for his researches in acoustics and magnetism, died on August 7, aged seventy-one years.

Dr. Humphrey Owen Jones, F.R.S., of Clare College, Cambridge, his wife and a Swiss guide, lost their lives on August 15 owing to an accident which occurred while they were ascending the Aiguille Rouge de Pentéret, in the Alps. Mr. Jones was in his thirty-sixth year and only married on the first of this month. For some years he had been demonstrator to the Jacksonian professor of natural experimental philosophy at Cambridge, and was amongst the most brilliant of the younger British chemists. He was elected into the Royal Society this year. Mrs. Jones was a member of Newnham College, and had been doing research work in the chemical laboratory in Cambridge for the past year. An even more eminent Cambridge man of science, Professor Francis Maitland Balfour, lost his life on the same mountain in July, 1882.

A valuable collection of British lepidoptera, made by the late Mr. John A. Finzi, has been presented by Mrs. and Miss Finzi to the Zoological Museum at University College, London.

At the meeting of the German Geological Society in Reiswald on August 8, a paleontological society was established. The organ of the society, *Die Paleontologische Zeitschrift*, will be published in Berlin by Borntraeger.

The third Clinical Congress of Surgeons of North America will be held in New York, November 11–16. The place of registration is, as we learn from the *Journal* of the American Medical Association, the ball room of the Waldorf-Astoria, where the daily program will be bulletined one day in advance and where printed programs of each day's clinics will be distributed. The work of the congress will be divided into six branches, namely: general surgery, gynecology, genito-urinary surgery, orthopedics, obstetrics and eye, ear, nose and throat surgery. In the evenings literary and scientific programs will be given as follows:

Monday, November 11—Presidential Meeting—Albert J. Ochsner, Chicago: Address of the retiring president. Edward Martin, Philadelphia (president's address): "Treatment of Hepatic Cirrhosis." William J. Mayo, Rochester, Minn.: "Surgery of the Large Bowel." Discussion by Charles H. Peck, New York City.

Tuesday, November 12—George W. Crile, Cleveland: "Kinetic Theory of certain Diseases, with special reference to Internal Secretions." Howard A. Kelly, Baltimore: Paper on Kidney Surgery. Discussion by George E. Brewer, New York City. Otfried Foerster, Breslau, Germany: "Indications and Results of Excision of the Posterior Spinal Nerve-roots." Charles H. Frazier, Philadelphia: Paper on Surgery of the Spinal Cord. Discussion by Charles A. Elsberg, New York City.

Authors and editors concerned with the preparation of illustrations for scientific purposes will find a booklet by L. P. Mosler on "Die moderne graphische Reproduction" of great service. It is issued by the firm of Gustav Fischer (Jena), famous for the superb illustrations in the scientific works bearing its imprint. Simple explanations are given of the principles underlying the making of line cuts; of half-tones, including duplex half tones, and the three and four-color processes; of heliotype, photogravure, and intaglio prints. Especial advice is given on the technical points involved in the preparation of good originals designed for these different processes.

The National Bureau of Standards is about to issue a circular entitled "State and Municipal Regulations for the Quality, Distribution and Testing of Illuminating Gas." This circular (133 pages, uniform in style with other bureau circulars) has been prepared after conference and correspondence with a large number of gas engineers and inspectors; and it represents, as nearly as possible, the average opinion of many men active in the field of gas manufacture and gas testing. Part I. of the circular gives a summary of the municipal gas ordinances now operative, presents a general discussion of municipal gas requirements, and proposes an ordinance largely compiled from the best ordinance requirements now in force. Part III. quotes a few ordinances typical of those recently enacted and gives the main portions of state gas laws now in force affecting gas quality, pressure and meter accuracy. The circular does not concern itself with financial regulation of gas companies nor does it include any discussion of the comparative value of various methods of works management. It deals mainly with the candlepower, heating value, purity and pressure of the gas and gas meter testing. The present publication has grown out of the investigation of the methods and standards employed in gas photometry and gas calorimetry, undertaken by the bureau three years ago. A second circular on the methods of testing employed for official inspection work is now being prepared. Although it can not be expected that the regulations for or methods of gas testing will ever be entirely uniform throughout the country, it is believed that if the results of a comprehensive investigation of the subject are published, a greater uniformity of method, and in some cases more accurate measurements will result. The attitude of the Bureau of Standards is entirely advisory and its intention is to place in the hands of the technical and general public an impartial and, as nearly as may be, an accurate summary of the facts which must be considered in connection with the fixing of standards of quality and the testing of illuminating gas. Revision of the circular from time to time is contemplated in order to amend the recommendations as to the requirements to adapt it to new developments in the gas industry. The circular is now in press and will be ready for distribution soon after April first. Copies may be obtained free of charge by addressing The Director, Bureau of Standards, Washington, D. C.

Nature states that the celebration of the jubilee year in the history of the two French reviews—the *Revue Bleue* and the *Revue Scientifique,* the subtitle of which is the *Revue Rose*—was held in Paris on June 12, at the Hôtel Continental. The editors were supported at a banquet by representatives of the Government, Parliament, the University and the Institute of France; in fact, not only were men of science, artists and men of letters present, but Parisian society generally united to do honor to the occasion. M. Ch. Moureu, the editor of the *Revue Scientifique,* in speaking in the name of science, dwelt on the advances made in science during the last fifty years, and was followed by M. Lippmann, president of the Paris Academy of Sciences, who referred appreciatively to the work done by our contemporary to assist the spread of scientific knowledge.

The museum committee of the Royal College of Surgeons has issued its annual report which is summarized in the London *Times.* Altogether the museum has been enriched by upwards of 1,000 specimens. The first place must be given to a collection which has been presented by the executors of the late Lord Lister through the president of the college, Sir Rickman J. Godlee. This comprises Lord Lister's surgical instruments, appliances used in early researches, records and tracings of experiments, drawings and pathological specimens. Another collection of surgical instruments, formerly the property of the Obstetrical Society, was presented by the Royal Society of Medicine, while Mr. Penrose Williams, of Bridgwater, has presented the whole of his collection, containing many desirable specimens. Of the primitive races now living, the native Australians are likely to prove the most instructive of the human body. The college has acquired by purchase several crania and skeletons of that race, while several presentations have been made which are of real value. Many rare and valuable specimens have been added to the series illustrating the osteology and diseases of the ancient Egyptians. Remains of ancient man have also been presented which were found in a cave, with wall decorations of a primitive type, in the south of Spain, and some casts of certain remains of ancient man which have given rise to much discussion in Europe. These are the only casts so far received in England. The Archeological Society of Broadstairs presented a series of skulls and skeletons belonging to the Bronze and Anglo-Saxon periods. These have been investigated and, for the first time, an approximately complete articulated skeleton of one of the Bronze Age men has been obtained. A medico-legal collection has been formed and a human femur, with photographs of human remains, found in the ruins after certain anarchists were besieged in Whitechapel, in January, 1911, has been presented. The new additions to the museum were specially exhibited on the occasion of the council election on July 4, and also on the two following days. There have been 12,231 visitors to the museum during the year.

UNIVERSITY AND EDUCATIONAL NEWS

THE following new buildings and additions are now in the course of construction at the University of Illinois: transportation building, mining building, ceramics building, locomotive testing laboratory, addition to woman's building, addition to agricultural building, commerce building, stock judging pavilion, agronomy greenhouses, sheep and horse barns. In addition to these the law building is being remodeled and plans and appropriations have been made for a new armory and new horticultural greenhouses.

STEPHEN TABER, A.B. (Stanford, '06), Ph.D. (Virginia, '12), for the past three years assistant geologist on the Virginia Geological Survey and instructor in geology in the university, has been elected to the chair of geology in the University of South Carolina.

MR. HERBERT OTTO LUSSKY, assistant in physiology at the University of Chicago, has been put in charge of the department of physiology in the college of arts and science and the college of medicine of the University of South Dakota.

PROFESSOR JOHN N. SWAN has leave of absence from Monmouth College for one year and will have charge of the department of chemistry in the University of Mississippi. Dr. A. M. Muckenfuss, who is at the head of the department, has leave of absence for a year. He will first complete some research work and then spend the remainder of the year in Germany. Mr. J. P. Trickey, of the University of Pittsburgh, will take charge of the chemistry at Monmouth College.

AT the recent meeting of the board of trustees of the University of Illinois the following promotions were authorized: Ernest L. Bogart, professor of economics; J. Howard Beard, instructor of physiology; Francis C. Lincoln, assistant professor of mining engineering, and Horatio N. Parker, instructor in municipal and sanitary dairying.

DISCUSSION AND CORRESPONDENCE

A NEW FOSSILIFEROUS HORIZON ON BLUEBERRY MOUNTAIN, IN LITTLETON, NEW HAMPSHIRE

LITTLETON, New Hampshire, has been particularly interesting to geologists because it is one of the few localities in the state where fossils have been found. These fossils are of Niagaran age.[1] They are contained in the

[1] Hitchcock, C. H., "New Studies in the Ammonoosuc District of New Hampshire," *Bull. Geol.*

lower members of a series of beds which, in the form of an irregular syncline, constitute the ridge known as Blueberry Mountain. The best specimens have been taken from the northern slope of Fitch Hill, the most northern eminence of the mountain. Here the succession of strata[2] is as follows: (1) A coralline limestone (30 to 50 feet thick)[3] resting unconformably upon an igneous foundation;[4] (2) a calcareous slate (5 to 8 feet thick)[3] in which are the impressions of brachiopods and trilobites; (3) limestone, partly dolomitic; (4) coarse feldspathic sandstone (arkose); (5) a thick mass of regularly banded argillites, passing upward into (6) a dark, pyritiferous sandstone. Previous to last summer no fossils had been found above the calcareous slate.[5]

In August, 1911, while engaged in geological investigations which were undertaken through the advice and generosity of Mr. R. W. Sayles, of the Harvard Geological Department, the writer discovered the distorted impressions of brachiopods, probably *Spirifer* or a related genus, in talus at the foot of the "crags," a precipice of the dark sandstone; but the specimens were not well preserved. In continuation of the same work, during the present summer, we chanced upon a fossiliferous sandy layer in the banded argillites, where a north-south road crosses the ridge between Blueberry Mountain and Bald Hill. This spot is two and a half miles from the Fitch Hill exposures of the same series, southwestward along the strike.

Soc. Am., Vol. 15, 1904, pp. 462, 479, 480. Also, by the same author, "The Geology of Littleton, New Hampshire," with an "Article on a Trilobite from Littleton and Notes on Other Fossils from the Same Locality," by A. E. Lambert. Reprint from the "History of Littleton." Published by the University Press, Cambridge, Mass., 1905, p. 38.

[2] *Op. cit.*, 1904, p. 464, and *op. cit.*, 1905, pp. 15, 34.

[3] *Op. cit.*, 1905, p. 34.

[4] We shall publish a more detailed report on the geology of Fitch Hill at a future date.

[5] *Op. cit.*, 1904, pp. 479, 481, and *op. cit.*, 1905, p. 31.

Since the lower part of the banded argillites is about 400 feet above the coralline limestone (omitting two thick basic sills which have been injected into the formation), and since this new locality is at least 300 feet above the base of the banded series, these fossils occur stratigraphically 700 feet or more above the Fitch Hill fossiliferous horizon.

The impressions are chiefly of brachiopods. They will be submitted for identification at the close of the field season. Meanwhile we shall make a more extended examination of the argillites.

Frederick H. Lahee

Littleton, N. H.,
August, 1912

A PUZZLING PHOTOGRAPH

To the Editor of Science: In the issue of *Collier's Weekly* for August 3, under the caption of "A Prehistoric Peruvian Graveyard," Grace Whitworth gives a halftone picture of a remarkable ossuary which is stated to have been taken from a structure discovered, by some person unnamed, in a tropical jungle on the Ucayali River in Peru. The structure is stated to be a square of 200 feet enclosed by a wall 25 feet high, built "apparently of red clay," with no entrances, and along the top of the wall at regular intervals it is ornamented with vases made of the same material. Inside was an immense mass of human bones free from any superincumbent deposit and mostly in an excellent state of preservation (judged by the picture) and in some parts of the enclosure heaped to a depth of 18 feet. "Some entire skeletons were lying out straight, while thousands of other skulls and bones appeared to have been dragged about, probably by buzzards."

Allowing nine feet for the average depth of the mass and one cubic foot for the space occupied by one skeleton, there should be a total possibly amounting to 72,000 human beings represented by the deposit.

In an ordinary newspaper such a communication might be allowed to pass unnoticed with snake and fish stories, but in the present instance it seems worth while to give some reasons why it seems practically certain that *Collier's* correspondent has been the victim of a hoax, especially as "an archeologist of repute" in America is stated to have said: "This looks very much as if we should have to begin our research all over again," presumably meaning in South American archeology.

To my mind, there is a probability, almost amounting to a certainty, that the photograph, which is certainly taken from a real scene, represents a structure which is not prehistoric, which is not South American, which is not the work of a savage people, and which is situated not in a tropical jungle subject to a rainy season like the Peruvian Ucayali, but in an arid country probably devoid of vegetation. Where or why it exists is a problem to be solved by some one better posted in Eurasian archeology than the present writer.

The halftone does not lend itself to magnification like an original photograph but it can be seen that the top of the wall is absolutely rectilinear and level, and provided on a bevelled edge with long smooth sloping slabs of some substance, probably stone, roofing it from the weather. These slabs are of uniform length, apparently about fifteen feet, and at their junctions are placed the vases on a presumably flat surface. The latter are of a "classical" design like no product of the American aborigines. No structure with such unvarying lines is known among American prehistoric ruins nor as the product of a people in a state of savagery.

It is notable that there is no trace of tropical or other vegetation in the picture. If some skeletons still remain in a natural position, and no deposit of vegetation or drift of dead leaves and mold has formed on this immense heap of bones, and those in the lower part of the heap seem (from the picture) to be perfectly preserved, it is evident that the deposit can not be prehistoric but is very recent; that it can not have been subject to tropical rains and blown débris for centuries, but must be in an arid climate where bones do not readily decay, and where there is no vegetation of a kind to form a covering of humus.

The picture is interesting enough in itself to be worth an authentic explanation.

Wm. H. Dall

Smithsonian Institution

"TERMS USED TO DENOTE THE ABUNDANCE OR RARITY OF BIRDS"

To the Editor of Science: I sympathize with Mr. John Dryden Kuser's desire to standardize the terms used to denote the abundance or rarity of birds,[1] but it seems to me that the chief difficulty is the inherent one that lies in the personal equation. No two persons can have just the same notion as to the precise meanings of the various terms used. What one calls rare another calls uncommon, and still another, having in mind the relativity of all such terms, may call the species "fairly common,"—*for* a hawk, for instance, hawks being judged by a different standard from warblers. Undoubtedly the best system is a numerical one when that is possible, the exact or estimated number of individuals observed being noted. That entails, however, in some cases an amount of labor that the observer may prefer to expend in other directions, while for generalizations it is unsatisfactory.

As to the list of terms with synonyms offered by Mr. Kuser, it seems to me that it is open to objection in some particulars. It is not quite clear, for one thing, just what he means when he states that "not uncommon is equal to common." Is he making an arbitrary ruling for his own guidance, or is he stating what he believes to be a fact? Presumably the latter, since he says he limits himself to eight terms, and "not uncommon" is not one of the eight listed. And yet I venture to express the belief that to most ornithologists the term "not uncommon" expresses a status distinctly less common than "common." It comes nearer to "fairly common," but to my mind means less common than that. In short, it seems to me that we can not treat

[1] Science, June 14, 1912, p. 930.

the English language exactly as we treat a mathematical equation. There are fine distinctions in words that we can not abolish by arbitrary rules.

I *quite* agree with Mr. Kuser that "quite common" is an incorrect expression as it is ordinarily used, but I am very sure that simple "common" does not fill its place, and I am not altogether certain that "fairly common" quite expresses it either, though perhaps that is the best substitute.

"Tolerably common," though it has the sanction of government usage, is also objectionable on etymological grounds, as Mr. Kuser points out.

"Frequent" strikes me as objectionable because it is an adjective of time rather than number or distribution in space. "Fairly common" or "rather common" are preferable, perhaps.

The statement that "accidental is occasional or rare" seems to me absolutely wrong. All birds that occur only accidentally or "casually" are rare, but not all rare birds can be called accidental. The distinction is generally recognized, I think. The accidental occurrence of a bird is supposed to be due to some stress of weather or similar outside force or possibly some abnormal tendency in the individual. No bird that is found regularly in a given locality, no matter how rare it may be, can be called accidental—unless, indeed, it is a single individual that is found thus regularly. Mockingbirds are still rare in Massachusetts, but they can no longer be called accidental, and the same is true of the Iceland, Kumlien's and glaucous gulls.

Mr. Kuser says that "very rare is using an unnecessary adverb, for rare is very rare," but are there not degrees of rarity, and, if so, why should we not be permitted to indicate them? Mr. William Brewster in "Birds of the Cambridge Region," calls the mourning warbler "rare in spring, exceedingly rare in autumn." Is there not a decided advantage in being able to make this distinction?

Is not Mr. Kuser's definition of "scarce" as indicating "that the bird mentioned was at some previous time common" a purely arbitrary one? If so, how can he expect its use in that sense to be generally adopted?

Finally I suggest that Mr. Kuser's definition of "irregular" be extended to cover the complete absence of a species during some seasons.

It was certainly worth while to call attention to the common use of vague and inaccurate terms in bird-lists, but as one who has made many lists (mostly unpublished), I have ventured to offer a few considerations which will serve to indicate that the standardization of the terminology is not so easy as it looks.

Francis H. Allen

West Roxbury, Mass.

POPULAR "SCIENCE" AGAIN

It is perhaps worth while calling the attention of the readers of Science to a fresh contribution to the pseudo-scientific literature of this country. In a recent number of *Mother's Magazine,* Dr. Cornelia B. DeBey writes concerning weeds as follows:

> Weeds may not seem (to you) to have much connection with your home hygiene, but they do have. Growing under the bedroom window, thriving in a corner of the yard, lining a back walk, they are constantly, through their nature, absorbing floating air poisons. As the period of their annual decay approaches, they throw off these poisons and the winds gather them up and sweep them through the house. They are blown into your lungs and into the lungs of your children. If perchance the system of any one of you happens to be weak at the time, a sickness may almost certainly be expected to follow.
>
> Weeds of the yard, like the foul dust of the streets of a city, carry millions upon millions of germs eager to thrive on any frail human or animal body. Root out the weeds. Treat them with scalding hot lye and wood ashes that have been soaked in hot water. Attack them with hoe and spade. Certain noxious weed growths, very common to American yards, may breed diphtheria, typhoid fever, scarlet fever and serious catarrhal affections.

The spirit of the foregoing is doubtless highly commendable, but the ideas of the causes of diseases inculcated in such a statement, are, at the very least, undesirable.

Ernst A. Bessey

QUOTATIONS

THE MEDICAL MAN AND RESEARCH

In a recent address on "Research Foundations in their Relation to Medicine"[1] the well-known neurologist of the Wistar Institute, Professor H. H. Donaldson, has expressed certain views which deserve to be heralded in medical circles beyond the immediate audience of graduates in medicine to which they were originally addressed. He has emphasized the fact that the programs of the large research foundations imply the hope that by such endowments new facts and new points of view fundamentally important to medicine may be discovered. Many of these establishments serve in a way to mediate between the problems of practise and the findings of science. The popular mind is constantly alert for some new application of science to the work of the world or the needs of the arts. Accordingly there is an ever-present tendency to place undue importance on the purely practical aspects of all research.

The worker who is engaged in the actual pursuit of scientific investigation realizes well enough that there is no essential distinction between so-called practical and theoretical knowledge. He would, indeed, be rash who would foretell where one type of contribution merges into the other. But with the laity the search for the unknown finds little encouragement except when it is attended by some palpable result of immediate application. Hence the pressure which many of our institutions feel to present something that will satisfy this unfortunate and mistaken public demand.

Precisely here the medical man of to-day has an opportunity and a duty. Trained in the school of modern science, he should have acquired an appreciation of the unhampered search for new knowledge which is so rarely intelligible to the community at large. He is more or less familiar with the aims of the research worker and has some understanding of what these endeavors have contributed to the world. He should defend the effort and help to spread the propaganda. We believe that the attitude of the practitioner toward certain features of medical research is, in general, wholesome and helpful in so far as these features involve relations to the problems of clinical medicine. There is, however, another class of problems which demand solution no less than some of the more obvious questions. These more subtle problems involve the "why" and "how." They are harder to answer; they appeal to fewer investigators, and not many men are adequately equipped to attack them. As Donaldson has said, because the men who can do this latter kind of work are relatively rare, even among investigators, because such work can have rational appreciation from a limited group only, and because knowledge of this sort is sure to become the basis for many applications in the future, it behooves us all to see to it that we foster such investigators—the most valuable of our natural resources. When a mistaken popular notion arises as an obstacle to progress we must help to remove it.

It has often been said that research is an attitude of mind. This is something different from the mysterious features which are sometimes attributed to it. The spirit of research is attainable, even if at times it seems remote. Quoting Donaldson: "A man may have little leisure and trifling resources, and may never have published; but if he examines the world in a questioning spirit, if he carries with him not only conclusions, but the observations on which they rest, if he refuses to pound square facts into the round holes that he happens to have in hand, he has attained illumination."—*Journal of the American Medical Association.*

[1] Donaldson, H. H., "Research Foundations in their Relation to Medicine," address at the graduation exercises of the Yale Medical School, Science, July 19, 1912.

SCIENTIFIC BOOKS

The Principles of Human Nutrition. By Whitman H. Jordan, director of the New York Agricultural Experiment Station. The Macmillan Company. 1912. Pp. 450. $1.75 net.

The object in view, as stated in the preface, was "such a presentation of the subject-matter related to human nutrition as would be more or less adapted to popular use, but particularly to instruction of students with moderate scientific acquirements, whether in colleges, secondary schools, short courses, schools of domestic science or correspondence schools." The volume is essentially one for the producer and consumer. It is written in non-technical language, and no chemical symbols are employed.

Part I. contains eight chapters (176 pages) dealing with the subjects: The Plant as a Source of Human Sustenance, The Chemical Elements Involved in the Nutrition of the Human Body, The Compounds of Human Nutrition (Chapters III. and IV.), The Digestion of Food, The Distribution and Transformations of the Digested Food, The Functions of Food Compounds, Laws of Nutrition. Part II. is devoted to practical dietetics and the chapters are headed: General Considerations, The Selection of Food or the Regulation of Diet, The Relation of Diet to the Varying Conditions of Life, Food Economics, Special Dietetic Methods, The Nutrition of the Child, The Character and Food Value of Certain Commercial Articles, The Preparation of Food, Food Sanitation, The Preservation of Foods. Pages 351–443 consist of tables showing the composition of American food materials.

A book on nutrition written for non-scientific readers can not justly be criticized for lack of strict scientific accuracy. In a few instances however the author seems to have incorporated material conveniently at hand instead of seeking the best available. For example, in Table II., page 16, is recorded the content of the principal mineral elements in a number of grains and vegetables. The figures are derived from Wolff's "Aschen Analysen" published in 1871. It is now well known that Wolff's values for sulfur, and in many cases for chlorine, are entirely unreliable. Again in Table XV., page 60, corn is listed as a protein and the values for its cleavage products are those given by Osborne and Clapp for zein. Osborne and Jones have expressed greater confidence in a later analysis of this protein.[1]

On page 25 occurs the statement that organic matter is of two classes: (1) protein and non-protein, and (2) carbohydrates, fats and acids. Misprints are occasionally met with but in general are not misleading. On page 34, however, a column of bases is headed acids, and again on pages 297–300 in four instances the cost of certain dietaries for children is given in fractions of a cent where it is evident that dollars are intended.

On page 128 hæmatin is used where hæmochromogen is meant, and on pages 129, 135 and 149 the same term is employed where hæmoglobin is the correct term.

Reformed spelling is employed in some cases but not in others. Thus on pages 68 and 74 xylose is spelled zylose, while saccharose is regularly spelled in the old fashioned way. On page 68 zylin is given as the equivalent of wood gum and as the mother substance of zylose. Similarly arabin is said to yield arabinose. Obviously xylan and araban are referred to. One might well question the wisdom of changing, without explanation, word endings having so definite a significance in carbohydrate nomenclature.

The data presented are on the whole reliable, and the errors noted should detract but little from the book when used by the class of students for which it is intended. It is written in a conversational style and is highly entertaining reading. The treatment of the economic and social aspects of human nutrition is somewhat better than the scientific, but it is decidedly the best non-technical treatment of the subject in general. The discussion of special dietetic practises (vegetarianism, uncooked food, etc.) is especially good, and the book should do much good in replacing the popular works on nutrition written by adherents to the various dietetic fads.

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[1] Osborne and Clapp, *American Journal of Physiology*, Vol. 20, 1908, p. 477. Osborne and Jones, *ibid.*, Vol. 26, 1910, p. 212.

Fergusson's Percentage Unit of Angular Measurement, with Logarithms; also a Description of his Percentage Theodolite and Percentage Compass. By John Coleman Fergusson. London, Longmans, Green & Co. 1912. 8vo. Pp. lxvii + 467.

This is one of those costly volumes printed occasionally to advocate some novel idea; not actually incorrect, but yet quite without real value. Such books are full of pathos. One can see in their pages lost yet endless industry; painful longing for sympathetic appreciation; indomitable energy; the sacrifice almost of a life-time; and finally the refusal to accept even the kindliest adverse criticism. Were not the theories of Galileo received with incredulity? Are not my theories met by similar unbelief? Galileo was right. So then must I be also. Such is the fallacious reasoning consciously or unconsciously in the minds of men like Fergusson.

The division of the circle has always been made hitherto in equal parts, ordinary degrees of arc or centesimal degrees. Fergusson proposes to divide the circle into unequal parts, one hundred spaces to each octant, or arc of 45° as ordinarily measured. To the new divisions will be attached numbers thus: 1%, 2%, . . . 10%, etc., in such a way that the number 10%, for instance, will belong to the angle whose tangent is 0.10, etc.

The author gives elaborate logarithmic tables computed for this new division of the circle; but it appears from his examples of their use that no saving of time or other advantage has been obtained. He has also had made an engineer's angle instrument provided with the new circle divisions; and has of course been unable to use a vernier. In its place is substituted a most complicated "micrometer drum screw."

The book is not free from humor: we recommend the following passage to the engineering and financial experts of Wall Street.

"*A* gives *X* £500 sterling for a half share in the sixth interest that *X* holds in a mining claim located at Eureka, Nevada, U. S. A. It is plain to everybody that *X* has received £500 sterling for the half share of his mining interest. *A*, on the other hand, has got for his money an acknowledgment, which, in itself, is a concrete function implying value; and this implied value is dependent on the geological formation of a piece of ground staked out in Nevada, the true value of which *A* may determine by the aid of a Philadelphia lawyer and a western mining expert. *A* has received *implicit* value; *X* got *explicit* value."

The author asserts that this "simple example" makes clear "the whole difference between the arithmetical and algebraic systems."

H. J.

SPECIAL ARTICLES

THE PRESENT STATUS OF THE BACTERIOLOGY OF HUMAN LEPROSY

Since the discovery by Hansen in 1872 of an acid-fast bacillus in the leprous lesion to which he ascribed an etiological rôle, numerous investigators have reported success with its artificial cultivation. It may be stated, however, that prior to 1901 the cultures isolated and described by various investigators differed tinctorially and morphologically from the Hansen bacillus of the tissues, and although many of these cultures were said to have induced experimental lesions similar to human leprosy and to have fulfilled other postulates, no one of them has been universally accepted as the specific organism of leprosy.

Kedrowski in 1901 described an organism which he cultivated from the leprous lesion and believed to be the specific bacillus of leprosy. This author reported his culture as a non-acid fast diphtheroid bacillus, which when injected into laboratory animals became acid-fast after a sojourn of weeks in the tissues. He advanced the theory that the acid-fast rods seen in human leprous lesions represent but a stage in the developmental cycle of a single pleomorphic species.

Deycke and Rost and Williams have since reported (1905) upon the successful cultivation from the leprous nodule of an organism similar to that of Kedrowski's together with which they also found streptothrical forms and acid-fast rods.

More recently Bayon (1912) describes a non-acid-fast diphtheroid obtained from a leper which behaves in a like manner to Kedrowski's culture, *i. e.,* the initial growth from the tissues is non-acid-fast and a diphtheroid until passed through rats, after which it permanently changes into a typical acid-fast bacillus. Like Rost and Williams he also mentions streptothrical forms in his culture. He concludes that not only is his culture identical with Kedrowski's, but also that it is the cause of human leprosy, basing his argument upon specific reactions obtained with human leper serum and also upon the production of characteristic lesions in laboratory animals.

Clegg in 1909 announced his success in the cultivation of an acid-fast bacillus which he isolated from lesions in a large series of lepers in the Philippines. He found that multiplication in each instance occurred in the transferred leprous tissue bits when planted with amœbæ and their symbionts. He subsequently obtained pure cultures of acid-fast organisms on the ordinary laboratory media as a moist, profuse, pigmented growth after heating at 60° C. for 30 minutes to kill out the symbionts.

The author (1910) described a method by which the bacilli in the leprous lesion could be cultivated in vitro without the use of symbionts. The culture differed from Clegg's in that it did not produce pigment and it refused to grow except upon special nutrients; however, cultures were subsequently isolated from a number of cases which in time became rapid growers and chromogenic. Other cultures similar to Clegg's have been reported by Brinkerhoff and Currie in Honolulu, Rivas in Philadelphia, Thompson in Australia, Wellman in California and workers in Hawaii.

The work of Rost, Williams, Kedrowski, Bayon and others, who have cultivated organisms other than acid-fast rods from leprous lesions, tends to show that the organism of leprosy is "an extremely pleomorphic streptothrix" which under certain circumstances may be: (1) A non-acid-fast streptothrix with interlacing filaments, (2) a non-acid-fast diphtheroid bacillus, which is in reality a streptothrix, and capable of becoming acid-fast under certain conditions, (3) a definite acid-fast filamentous streptothrix, or (4) an acid-fast bacillus which is the broken-down stage of a streptothrix.

A review of the literature would seem to show that three or possibly four apparently different germs have been cultivated and described as the causal agent of human leprosy; namely, (1) a non-acid-fast diphtheroid (Kedrowski), (2) an acid-fast chromogenic bacillus (Clegg), (3) non acid-fast and acid-fast interlacing and filamentous streptothrix (Rost & Williams), and (4) a bacillus which *in vitro* maintains the morphology and staining reaction of the Hansen bacillus of the tissues and grows under artificial conditions only in the presence of special nutrients (Duval).

Acid-fast and non-acid-fast filamentous forms I have also encountered in certain of the cultures which become chromogenic and rapid growers, but branching non-acid-fast streptothrices I have never noted in the acid-fast culture which is non-chromogenic and refuses to multiply except upon special media.

The marked variation in morphology and staining properties of the chromogenic culture I have regarded as involution or degeneration forms of the species. However, it is noteworthy that by plating out the chromogenic culture, separate colonies of non-acid-fast streptothrices and non-acid-fast diphtheroids are recovered, and these are converted into acid-fast rods by alterations in the reaction of the medium, etc.

Since we may encounter in the leprous lesion a pleomorphic organism which is capable of changing in vitro under defined conditions, it is easy to explain the bewildering number of "stages" for the supposedly cultivated Hansen bacillus of some writers.

Whether the various cultures reported as the Hansen bacillus represent the same or distinct species, some one of which is the real exciter of leprosy and the others simply extraneous or accidental commensals, is a problem yet unsolved; however, by a comparative study of the lesions induced experimentally, the behavior of the cultures with respect to immune sera and by other well-known methods it is hoped that the proper status of the various cultures will be established.

In Louisiana I have attempted the cultivation of the Hansen bacillus from 29 cases of leprosy and have succeeded in isolating an acid-fast bacillus from 22 of these cases. The chromogenic variety was recovered from 14 cases while 8 yielded a non-chromogenic acid-fast bacillus which thus far has refused to produce pigment or multiply on the ordinary laboratory media, and in one case a non-acid-fast diphtheroid was recovered.

For many generations the sub-plants both of the chromogenic and of the non-pigment producing types have each remained well within the variations of a species and have in general maintained very closely the morphology of the Hansen bacillus as we know it in the tissues.

In the 14 cases above mentioned the acid-fast culture recovered has eventually undergone a marked change in morphological and cultural features after which it could be propagated upon the ordinary laboratory media. These cultures which become chromogenic correspond in all essentials to Clegg's original isolation.

In the 8 cases referred to, the non-chromogenic culture, although behaving much as did the Clegg chromogenic bacillus for the first two or three months under artificial growth conditions, has refused to produce pigment or grow on ordinary media.

Since the chromogenic culture behaved much in the same manner as the non-chromogen during the first three or four months of artificial cultivation, I have looked for a similar change to occur in this particular "slow-growing" strain. It would seem that it will not become saprophytic as the period of parasitism experienced with the cultures which subsequently became chromogenic and distinctly vegetative has long passed.

It is hard to explain the occurrence in the leprous lesion of the chromogenic acid-fast, which in my experience with cases here is encountered more frequently than the non-chromogenic variety. Curiously enough the chromogenic type, if we are to regard it as an extraneous organism, is always the same variety, that is, a moist rapidly growing diplococcoid bacillus when once it becomes accustomed to an artificial environment. I have compared the seven original cultures of Clegg, and those isolated independently by workers in Hawaii, Honolulu and London with the chromogenic cultures isolated here and find them identical except for minor inconstant differences. That the chromogen exists in the lesion of certain types of leprosy there can be no doubt, even where the overlying skin is apparently intact, and also in the internal organs at autopsy, more particularly the spleen. If these cultures are extraneous saprophytes it is hard to explain that they should occur in so large a percentage of cases. Of course it is well known how ubiquitous are the saprophytic acid-fast species, it being possible to isolate them from almost any source outside the animal body. Their occasional occurrence, therefore, in the open skin lesion of leprosy is to be expected, but to find them so frequently is difficult to explain if we are to accept that they are in no way concerned in leprosy.

The initial multiplication in vitro of both the acid-fast strains referred to is accomplished with comparative ease, provided that the bits of leprous tissue transferred are treated in such a way that the protein moiety is split into its dissociate products.

This action upon the protein of the removed leprous lesion may be accomplished in the following ways: (1) By seeding the tissue transplants with some one of the putrefactive bacteria or with any species capable of hydrolyzing the tissues; (2) by saturating the removed tissue bits with a one-per-cent. trypsinized albumen solution; or (3) by transferring the leprous material directly to a medium containing the products of protein digestion.

With any of these methods the acid-fast bacilli in bits of the removed lesion will multiply and continue to do so as long as these products are present.

To establish, if possible, an etiological rôle for any one of the cultures obtained from the human leprous lesion to the exclusion of others, careful comparative studies of the experimentally induced lesion and the serological tests have been carried out upon a large series of animals.

In general it may be stated that macroscopically the lesions produced in the lower animals do not differ greatly for any of the cultures employed, unless it be that the chromogenic type produces lesions which appear earlier and are more localized. Microscopically the cell picture or relation of the bacilli to the cells is not sufficiently distinctive of any culture to warrant more than a tentative differentiation.

In other words the experimental lesions in animals afford no absolute differentiation for any strain of acid-fast organism except of course the tubercle family. Leprous-like lesions are as readily induced experimentally with some of the well-known saprophytic species as they are induced with either the infested leprous tissues or with the lepra culture.

The serological tests with the blood of lepers has not established an etiological rôle for any type of acid-fast organism recovered from the leprous lesion. The agglutination reaction with the lepers' blood rarely gives a positive reaction in dilution of 1/50 with the separated Hansen bacilli obtained from the human nodule, while in the majority of cases a reaction is not obtained above a dilution 1/10. On the other hand, many of the tubercle family and the acid-fast saprophytes react equally as well and not infrequently in higher dilutions. The complement deviation tests with culture antigen utterly fail to show anything specific for the various cultures in so far as the human serum is concerned. However, the serum reaction of animals immunized against the various acid-fast species has served to separate into three distinct groups the chromogenic culture of leprosy (Group I.), the author's non-chromogenic culture of leprosy (Group II.) and the chromogenic saprophytic acid-fast species (Group III.). The reaction with specific immune sera establishes the fact that there is a difference between the non-chromogenic and the chromogenic leprosy cultures. Furthermore the serum reaction indicates no relation between these two strains and no relation of either to any known saprophytic species.

SUMMARY AND CONCLUSIONS

There may be cultivated from the leprous lesion two types of acid-fast bacilli which have distinct characteristics: one an organism which after it has become accustomed to a saprophytic existence produces pigment and becomes extremely pleomorphic; the other a bacillus growing slowly and only upon special media, and retaining always the tinctorial properties of the Hansen bacillus of the tissues. Non-acid-fast diphtheroids are occasionally encountered in the external lesions, but are perhaps accidental contaminators.

The acid-fast strain, which subsequently becomes a rapid grower and develops pigment, shows a wide variation in morphology and ability to retain the stain when subjected to decolorizing agents. At times and under certain conditions the individual bacilli are diphtheroid, streptothrical and non-acid-fast. The slow growing non-chromogenic culture is always acid-fast and can be sharply differentiated from the chromogenic culture by its growth features.

The animal experiments undertaken for the purpose of differentiating the acid-fast organisms recovered from the human leprous lesion and to fix their etiological status are not regarded as conclusive.

The serological tests, especially those performed with highly immune sera, have proven of some value and suggest that the bacillus of Clegg is not related to any known saprophytic acid-fast chromogen, and that the non-chromogenic slow-growing culture from leprosy is different both from Clegg's isolation and from all known species of acid-fast bacilli.

The rôle played by the chromogenic bacillus of Clegg in the production of leprosy is as yet an unsettled question.

The non-chromogenic strain, while behaving according to most of our notions regarding a pathogenic organism, has likewise not up to the present been proven to be the cause of leprosy, although I am impressed with the probability of such a rôle being eventually attributed to it, and consider that it deserves more serious attention than any strain so far cultivated from the human leprous lesion.

The wide variation in morphology and staining reaction for the culture recovered from the human leprous lesion which subsequently becomes a rapid grower and chromogenic, might account for the interpretations of Kedrowski, Rost, Williams, Bayon and others that *B. lepræ* is a bacterium of such pleomorphism that it can be recognized as a non-acid-fast diphtheroid, or streptothrix, and as an acid-fast bacillus.

CHARLES W. DUVAL

THE LAGOMORPHS AN INDEPENDENT ORDER

THE order Rodentia, as at present understood, includes two great groups, or suborders, commonly called the Duplicidentata and the Simplicidentata. Marked distinctions between these groups have long been recognized, yet they have been retained in a single order because of (1) a similar development of large scalpriform incisors and (2) certain similarities in the morphology of the brain and reproductive system which have been regarded as determining relationship. It has been argued[1] that these similarities the more surely denote relationship because of their deep-seated nature. When it is remembered, however, that in development of both brain and reproductive system the groups under discussion are very primitive, differing in these respects but slightly from the Insectivora, Chiroptera, Edentata and Marsupialia, these similarities lose much of their significance, and seem to be far outweighed by the many differences of other early acquired anatomical specializations, especially of the skull and feet. These differences gain in importance when it is considered that, whereas the Simplicidentata are an exceedingly diversified group, both in life and food habits and consequent morphological modifications, while both groups have an almost world-wide distribution, yet there are no known connecting links or intermediate forms, either living or extinct, even though such forms as the jerboas among the true rodents have outstripped the Lagomorphs in specialization for the leaping mode of progression. Paleontological evidence is admissibly very incomplete, yet so far as it goes it indicates clearly two important facts: first that both groups under discussion are of very ancient origin, the known forms showing but slight modification from the early Oligocene up to the present day, and second that in both groups the scalpriform incisor teeth were very early acquired. The latter fact through early limiting their food habits to a certain degree may account in a large measure for the retention in each group of similar primitive characters. In other and widely differing orders scalpriform incisors have been independently acquired, as in the toxodonts, the pyrotheres, the lemurs (*Daubentonia*, aye-aye), the allotheres (*Polymastodon*), the tillodonts and the hyracoids. Even among the artiodactyls a close approximation to this form of incisor has been reached, in the lower jaws, by such forms as the llama and the aberrant goat, *Myotragus*. This character, therefore, is not peculiar to the lagomorphs and rodents, and may very well have been quite independently acquired by these groups. Moreover, certain peculiarities in the structure and development of the incisors in the lagomorphs suggest the truth of this assumption.

Since, therefore in our present state of knowledge there is apparently no good reason for continuing the association of these two great groups of mammals and since, owing to the great number of important differences between them, it is far more convenient for purposes of classification and comparison with other forms to consider them separately, there seems ample reason for placing the Duplicidentata in an independent order. This new order may be called the Lagomorpha, adopting the old subordinal name given to this group by Brandt.

[1] Gregory, *Bull. Amer. Mus. Nat. Hist.*, Vol. 27, p. 325, 1910.

The order may be defined and distinguished from the Rodentia as follows:

LAGOMORPHA

Incisors, four above (functional), six in young individuals.

Functional premolars, three above and two below.

Dental formula $I\frac{2}{1}$, $Pm\frac{3}{2}$, $M\frac{3}{3}$ or $\frac{2}{3}$ rarely $\frac{2}{2}$.

Palate broad, distance between upper tooth rows much greater than the lower.

Upper cheek-teeth much wider than the lower.

Surface of glenoid fossa divided into two parts, an anterior ridge and a posterior pocket, thus limiting the jaws to a lateral motion only in chewing.

Cheek-tooth row in plane with ascending ramus of lower jaw.

Cæcum with spiral fold.

Elbow joint modified, not permitting of rotary motion of the forearm.

Fibula fused with tibia, distally, and articulating with calcaneum.

RODENTIA

Incisors, two above, never more than two in young individuals.

Functional premolars never more than one above and one below.

Dental formula $I\frac{1}{1}$, $Pm\frac{1 \text{ or } 2}{1}$ or $\frac{0}{0}$, $M\frac{3}{3}$ or $\frac{2}{2}$.

Palate progressively narrow, distance between upper tooth rows less than the lower.

Upper and lower cheek-teeth about equal in width.

Surface of glenoid fossa broad and continuous, permitting both anteroposterior and lateral motion of the jaws in chewing.

Cheek-tooth row lying inside plane of ascending ramus of lower jaw.

Cæcum without spiral fold.

Elbow joint primitive, permitting free rotary motion of the forearm.

Fibula fused or free, distally, but never articulating with the calcaneum.

Other differences than those given above might be added to the list, but these, if properly weighed, seem to suffice. True, some of the characters here given seem trivial, as, for instance, the difference in numbers of the upper incisor teeth. In some groups of mammals this character is not regarded as of more than specific value, but in the groups under discussion, in the light of other important modifications, it denotes a fundamental difference in the mechanical construction of the dentary system, and thus assumes a far greater importance.

As understood by the writer, both the Lagomorphs and the Rodents represent very ancient orders, whose origin dates so far back in time, and about which so little is known owing to the lack of fossil remains, that their real relationships to other placentals and to each other are at present very uncertain. However, from present evidence the former seem not to stand any closer to the Rodentia than to some other of the great groups of the mammalia. In this connection it is interesting to note some apparently early acquired characters in which the Lagomorphs have paralleled the higher ungulates.[2] The more important of these are: (1) modifications of the dental system, such as (*a*) broad palate with distance between the upper tooth rows much greater than the lower (ruminant), (*b*) upper molariform teeth wider than the lower, (*c*) manner of chewing on one side at a time with a lateral motion of the jaws; (2) modifications of the limbs and feet, (*a*) radius lying anteriorly to the ulna proximally, with articular face extending the full width of the humerus, (*b*) humerus with well-developed intertrochlear ridge, (*c*) fibula articulating strongly with the anterior face of the calcaneum (artiodactyl); (3) dorso-lumbar vertebræ 19 (artiodactyl, rodent).

These characters, while perhaps in no way denoting relationship to the higher ungulates, nevertheless indicate an advance in general development beyond the Rodentia which mark the later as the more primitive order. The existing differences in the brain and reproductive organs seem also to favor this conclusion.

The present article is intended simply to present the principal grounds for establishing a new order for the Lagomorphs, without attempting a full discussion of the subject.

James W. Gidley

[2] Some of these characters were pointed out by Cope in 1883, Report U. S. Geological Survey, on Terr., F. V. Haden, Vol. III., p. 813.

NOTE ON THE DINOSAUR-TURTLE ANALOGY

In my paper, "Notes on the Armored Dinosauria,"[1] I first gave general form to the idea that there is a distinct structural parallel between the armor of turtles and Dinosaurs, but that while in the former fixity and regularity of pattern were early developed, in the latter bizarre patterns were assumed. The main thought was also mentioned in a brief earlier paper of March, 1909, in the same *Journal.*

But this view can be made much clearer now. Both Hay and later Von Huene[2] agree in pointing out that the so-called parietal extensions of *Triceratops* are in reality projections formed by the fusion of elements which should be called *dermo-parietals.* I go further and state that this is not only correct, but that in all probability there are two additional lateral dermal elements fused with the squamosals, hypothetically the *dermo-squamosals;* and the hypothesist is clearly at liberty to go on and say that the horns as well may include equivalent dermo-cornutal elements. Now any such dermo-cornutal region may, and both the dermo-parietal and dermo-squamosal region must belong to the same deep dermogene layer in the Ceratopsidæ that in *Polacanthus* and all the Nodosauridæ gives rise to what I descriptively call the lumbar-hip-carapace which clearly results from the fusion of dermo-iliac plates. For in all these instances, whether in the skull region of the Ceratopsids, or the post-dorsal region of *Polacanthus,* we see the bones of this primary deep dermal layer undergoing direct fusion with the endoskeleton, just as in the dorsum of the turtles. Moreover, just as I proved in the case of the early turtles like *Archelon* and *Toxochelys Bauri,* the bones of this deep layer bear or are ridden by those of an outer superficial layer. The demonstration of this superficial layer and its *run in keels* of course explained the origin of the osteodermal carapace of *Dermochelys.*

Homologously the outer osteodermal layer is represented in the Ceratopsids by the *epoccipitals,* as Marsh called them, which *ride* the dermo-parietal and dermo-squamosal region and by the similar usually keeled series of various Dinosaurs. Only in *Stegosaurus* is it difficult to state whether the two huge rows of dorsal spines belong to the outer, or to the nether dermogene armor-producing layer; while it is not absurd to suggest that the dorsal plates could possibly result from the fusion of elements of both layers. Though we should not lose sight of the alternative explanation that the skull plates of *Ankylosaurus,* the horns and frill of *Triceratops,* the dorsal plates of *Stegosaurus* and the dermo-iliac elements of *Polacanthus, Nodosaurus* and *Stegopelta* may all be homologous elements of a dominant midline armor arising from the deep dermogene layer and thus in part analogous to the pleuralia of turtles.

Similarly, going much further afield, it is entirely possible that in the origin of the extraordinary supra-occipital crest of *Pteranodon* brought to light in the course of the admirable studies of Eaton, some strictly dermal element has played a part. And, indeed, responsive or counter growth of the endoskeleton finally resulting in fusion with dermogene elements and the complete obliteration of sutural lines, is of common observation in the Vertebrata, being essentially a senile course of development, which has to do with the aging of races quite as much as the production of purely protective features. The studies of Beecher on the origin of spines have interest in this connection.

Going back to the first premise: As noted, in strong contrast to crocodile-like reptilian types with an outer dermogene bone-producing layer only, the turtles originally had prominently developed, both the outer and nether dermogene layers. But they early tended to strengthen and use the under layer only along very conservative lines, and in their history never developed cranial armature, save in the comparatively recent and altogether aberrant *Meiolania.* On the contrary, as fusion of the dermogene with the chondrogene elements of the carapace and plastron went on, the armorless head became more or less retractile; while the carapace and plastron, though of

[1] *American Journal of Science,* February, 1911.

[2] *Neues Jahrbuch,* Jahrg. 1911, p. 146, 1912.

virtually senile origin, have plainly been the primary factor in giving to the Testudinata an exceedingly long lease of life.

Appositely, in the Dinosauria, a far more active and aggressive race, strong development of both body and cranial armature, in both the upper and the nether dermogene layers, largely confines itself to the bizarre patterns of Cretaceous times. Thus, it is plainly the under layer which gives rise to the huge plate roofing the entire skull in the remarkable genus *Ankylosaurus* of Brown. In the Ceratopsids, as stated, the outer dermogene layer forms the epoccipital fringe of the under stratum, which is not, as at first supposed, an excrescent skull growth, but deep dermal bone in reality strictly homologous to the hip armature of *Polacanthus*. Considered separately, we can reach but indefinite surmises as to the mode of origin or the meaning of these armor features. But clearly, when taken in their complementary relation, unity is restored to the armored series, and the simple structure generalization which clears up its true nature is at once discerned.

In a word, then, the Dinosaurs, instead of eventually confining extensive dermal development to a single nether layer covering the body region only, as in the turtles, tended to develop both the nether and outer layers in the body or skull or both. And this is only another but definite way of saying that the dermal armature was variously developed in the Dinosauria, or that it tended to assume bizarre patterns, whether we consider the final results as devices for offense or defense, or a primary or secondary use of dermal ossifications of essentially senile nature or origin. In either case, in strong contrast to the conservative armor development seen in the turtles, this growth of the most formidable armature known in land animals must have resulted in a most delicately balanced environmental adjustment in the entire race of armored Dinosaurs.

Obviously, too, this conception of the Dinosaurian armor as arising from the two dermogene bone-forming layers is still further simplified on observing the constant tendency of the separate plates or elements to develop nodes of growth which could arise anywhere on their surfaces or borders, in series forming the most ornate patterns. The plate, or flat dermal element, thus lifts itself up by the simplest process into the great frill of *Triceratops*, the tremendous erect flat plates of *Stegosaurus*, or the huge caudal spines of the latter animal or of *Nodosaurus* or those of *Hierosaurus*. Furthermore, the development of the supracranial horn-cores in *Triceratops* can, whatever their origin, offer no difficulty to the parallel between Dinosaurian and Testudinate armature here drawn, since these features are at least morphologically repeated in *Meiolania*. In both these cases, too, the horns may be viewed as exceptional structures quite apart from the dermal growth and modifications characteristic of turtles, and now known to have been present in an immensely varied and cosmopolitan series of Dinosaurians. The summation we therefore fairly reach is that the growth impulse in the dermogene layers which forms *the* pre- or *dermo-dentary* diagnostic of the Predentata, culminates in the *rostral, dermocornutal* and *frill* investiture of the Ceratopsids; while the dorsal armor of the Stegosaurs, and the cranio-dorsal armature of the Nodosaurids are all structurally homologous—it being in most cases plain to which of the two dermogene bone-producing layers any given element belongs, just as in the Testudinata.

In closing, I may be allowed to assert that this exceedingly simple explanation of the Dinosaurian armor at once gives us a clearer conception of the relationships of the various Dinosaur groups, and invites renewed study for the purpose of determining what endoskeletal variations resulted secondarily to the development of the dermal armor. It encourages us to believe, moreover, that the day can not be far distant when some of the proximate causes of armor development may be discerned, now that we see that armored Dinosaurs are by no means so strangely or fundamentally different from other Dinosaurs or even from other reptiles, as was once supposed.

G. R. Wieland

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THE NATURE, ORIGIN AND MAINTENANCE OF LIFE[1]

Everybody knows, or thinks he knows, what life is; at least, we are all acquainted with its ordinary, obvious manifestations. It would, therefore seem that it should not be difficult to find an exact definition. The quest has nevertheless baffled the most acute thinkers. Herbert Spencer devoted two chapters of his "Principles of Biology" to the discussion of the attempts at definition which had up to that date been proposed, and himself suggested another. But at the end of it all he is constrained to admit that no expression had been found which would embrace all the known manifestations of animate, and at the same time exclude those of admittedly inanimate, objects.

The ordinary dictionary definition of life is "the state of living." Dastre, following Claude Bernard, defines it as "the sum total of the phenomena common to all living beings." Both of these definitions are, however, of the same character as Sydney Smith's definition of an archdeacon as "a person who performs archidiaconal functions." I am not myself proposing to take up your time by attempting to grapple with a task which has proved too great for the intellectual giants of philosophy, and I have the less disposition to do so because recent advances in knowledge have suggested the probability that the dividing line between animate and inanimate matter is less sharp than it has

[1] Address of the president of the British Association for the Advancement of Science given at the Dundee meeting, 1912. The introductory remarks and the footnotes have been omitted.

hitherto been regarded, so that the difficulty of finding an inclusive definition is correspondingly increased.

As a mere word "life" is interesting in the fact that it is one of those abstract terms which has no direct antithesis; although probably most persons would regard "death" in that light. A little consideration will show that this is not the case. "Death" implies the pre-existence of "life"; there are physiological grounds for regarding death as a phenomenon of life—it is the completion, the last act of life. We can not speak of a non-living object as *possessing* death in the sense that we speak of a living object as *possessing* life. The adjective "dead" is, it is true, applied in a popular sense antithetically to objects which have never possessed life; as in the proverbial expression "as dead as a door-nail." But in the strict sense such application is not justifiable, since the use of the terms dead and living implies either in the past or in the present the possession of the recognized properties of living matter. On the other hand, the expressions *living* and *lifeless, animate* and *inanimate,* furnish terms which are undoubtedly antithetical. Strictly and literally, the words animate and inanimate express the presence or absence of "soul"; and not infrequently we find the terms "life" and "soul" erroneously employed as if identical. But it is hardly necessary for me to state that the remarks I have to make regarding "life" must not be taken to apply to the conception to which the word "soul" is attached. The fact that the formation of such a conception is only possible in connection with life, and that the growth and elaboration of the conception has only been possible as the result of the most complex processes of life in the most complex of living organisms, has doubtless led to a belief in the identity of life with soul. But unless the use of the expression "soul" is extended to a degree which would deprive it of all special significance, the distinction between these terms must be strictly maintained. For the problems of life are essentially problems of matter; we can not conceive of life in the scientific sense as existing apart from matter. The phenomena of life are investigated, and can only be investigated, by the same methods as all other phenomena of matter, and the general results of such investigations tend to show that living beings are governed by laws identical with those which govern inanimate matter. The more we study the manifestations of life the more we become convinced of the truth of this statement and the less we are disposed to call in the aid of a special and unknown form of energy to explain those manifestations.

The most obvious manifestation of life is "spontaneous" movement. We see a man, a dog, a bird move, and we know that they are alive. We place a drop of pond water under the microscope, and see numberless particles rapidly moving within it; we affirm that it swarms with "life." We notice a small mass of clear slime changing its shape, throwing out projections of its structureless substance, creeping from one part of the field of the microscope to another. We recognize that the slime is living; we give it a name—*Amœba limax*—the slug amœba. We observe similar movements in individual cells of our own body; in the white corpuscles of our blood, in connective tissue cells, in growing nerve cells, in young cells everywhere. We denote the similarity between these movements and those of the amœba by employing the descriptive term "amœboid" for both. We regard such movements as indicative of the possession of "life"; nothing seems more justifiable than such an inference.

But physicists show us movements of a precisely similar character in substances which no one by any stretch of imagination can regard as living; movements of oil drops, of organic and inorganic mixtures, even of mercury globules, which are indistinguishable in their character from those of the living organisms we have been studying: movements which can only be described by the same term amœboid, yet obviously produced as the result of purely physical and chemical reactions causing changes in surface tension of the fluids under examination. It is therefore certain that such movements are not specifically "vital," that their presence does not necessarily denote "life." And when we investigate closely even such active movements as those of a vibratile cilium or a phenomenon so closely identified with life as the contraction of a muscle, we find that these present so many analogies with amœboid movements as to render it certain that they are fundamentally of the same character and produced in much the same manner. Nor can we for a moment doubt that the complex actions which are characteristic of the more highly differentiated organisms have been developed in the course of evolution from the simple movements characterizing the activity of undifferentiated protoplasm: movements which can themselves, as we have seen, be perfectly imitated by non-living material. The chain of evidence regarding this particular manifestation of life—movement—is complete. Whether exhibited as the amœboid movement of the proteus animalcule or of the white corpuscle of our blood; as the ciliary motion of the infusorian or of the ciliated cell; as the contraction of a muscle under the governance of the will, or as the throbbing of the human heart responsive to every emotion of the mind, we can not but conclude that it is alike subject to and produced in conformity with the general laws of matter, by agencies resembling those which cause movements in lifeless material.

It will perhaps be contended that the resemblances between the movements of living and non-living matter may be only superficial, and that the conclusion regarding their identity to which we are led will be dissipated when we endeavor to penetrate more deeply into the working of living substance. For can we not recognize along with the possession of movement the presence of other phenomena which are equally characteristic of life and with which non-living material is not endowed? Prominent among the characteristic phenomena of life are the processes of assimilation and disassimilation, the taking in of food and its elaboration. These, surely, it may be thought, are not shared by matter which is not endowed with life. Unfortunately for this argument, similar processes occur characteristically in situations which no one would think of associating with the presence of life. A striking example of this is afforded by the osmotic phenomena presented by solutions separated from one another by semipermeable membranes or films, a condition which is precisely that which is constantly found in living matter.

It is not so long ago that the chemistry of organic matter was thought to be entirely different from that of inorganic substances. But the line between inorganic and organic chemistry, which up to the middle of the last century appeared sharp, subsequently became misty and has now disappeared. Similarly the chemistry of living organisms, which is now a recognized branch of organic chemistry, but used to be considered as so much outside the domain of the chemist that it could only be dealt with by those whose special business it was to study "vital" processes, is passing every day more out of the hands of the biologist and into those of the pure chemist.

Somewhat more than half a century ago Thomas Graham published his epoch-making observations relating to the properties of matter in the colloidal state: observations which are proving all-important in assisting our comprehension of the properties of living substance. For it is becoming every day more apparent that the chemistry and physics of the living organism are essentially the chemistry and physics of nitrogenous colloids. Living substance or protoplasm always, in fact, takes the form of a colloidal solution. In this solution the colloids are associated with crystalloids (electrolytes), which are either free in the solution or attached to the molecules of the colloids. Surrounding and enclosing the living substance thus constituted of both colloid and crystalloid material is a film, probably also formed of colloid, but which may have a lipoid substratum associated with it (Overton). This film serves the purpose of an osmotic membrane, permitting of exchanges by diffusion between the colloidal solution constituting the protoplasm and the circumambient medium in which it lives. Other similar films or membranes occur in the interior of protoplasm. These films have in many cases specific characters, both physical and chemical, thus favoring the diffusion of special kinds of material into and out of the protoplasm and from one part of the protoplasm to another. It is the changes produced under these physical conditions associated with those caused by active chemical agents formed within protoplasm and known as *enzymes*, that effect assimilation and disassimilation. Quite similar changes can be produced outside the body (*in vitro*) by the employment of methods of a purely physical and chemical nature. It is true that we are not yet familiar with all the intermediate stages of transformation of the materials which are taken in by a living body into the materials which are given out from it. But since the initial processes and the final results are the same as they would be on the assumption that the changes are brought about in conformity with the known laws of chemistry and physics, we may fairly conclude that all changes in living substance are brought about by ordinary chemical and physical forces.

Should it be contended that growth and reproduction are properties possessed only by living bodies and constitute a test by which we may differentiate between life and non-life, between the animate and inanimate creation, it must be replied that no contention can be more fallacious. Inorganic crystals grow and multiply and reproduce their like, given a supply of the requisite pabulum. In most cases for each kind of crystal there is, as with living organisms, a limit of growth which is not exceeded, and further increase of the crystalline matter results not in further increase in size but in multiplication of similar crystals. Leduc has shown that the growth and division of artificial colloids of an inorganic nature, when placed in an appropriate medium, present singular resemblances to the phenomena of the growth and division of living organisms. Even so complex a process as the division of a cell-nucleus by karyokinesis as a preliminary to the multiplication of the cell by division —a phenomenon which would *primâ facie* have seemed and has been commonly regarded as a distinctive manifestation of the life of the cell—can be imitated with solutions of a simple inorganic salt, such as chloride of sodium, containing a suspension of carbon particles; which arrange and rearrange themselves under the influence of the movements of the electrolytes in a manner indistinguishable from that adopted by the particles of chromatin in a dividing nucleus. And in the process of sexual reproduction, the researches of J. Loeb and others upon the ova of the sea-urchin have proved that we can no longer consider such an apparently vital phenomenon as the fertilization of the egg as being the result of living material brought to it by the spermatozoon, since it is possible to start the process of division of the ovum and the resulting formation of cells, and ultimately of all the tissues and organs—in short, to bring about the development of the whole body—if a simple chemical reagent is substituted for the male element in the process of fertilization. Indeed, even a mechanical or electrical stimulus may suffice to start development. *Kurz und gut,* as the Germans say, vitalism as a working hypothesis has not only had its foundations undermined, but most of the superstructure has toppled over, and if any difficulties of explanation still persist, we are justified in assuming that the cause is to be found in our imperfect knowledge of the constitution and working of living material. At the best vitalism explains nothing, and the term "vital force" is an expression of ignorance which can bring us no further along the path of knowledge. Nor is the problem in any way advanced by substituting for the term "vitalism" "neo-vitalism," and for "vital force" "biotic energy." "New presbyter is but old priest writ large."

Further, in its chemical composition we are no longer compelled to consider living substance as possessing infinite complexity, as was thought to be the case when chemists first began to break up the proteins of the body into their simpler constituents. The researches of Miescher, which have been continued and elaborated by Kossel and his pupils, have acquainted us with the fact that a body so important for the nutritive and reproductive functions of the cell as the nucleus—which may be said indeed to represent the quintessence of cell-life—possesses a chemical constitution of no very great complexity; so that we may even hope some day to see the material which composes it prepared synthetically. And when we consider that the nucleus is not only itself formed of living substance, but is capable of causing other living substance to be built up; is, in fact, the directing agent in all the principal chemical changes which take place within the living cell, it must be admitted that we are a long step forward in our knowledge of the chemical basis of life. That it is the *form* of nuclear matter rather than its chemical and molecular structure which is the important factor in nuclear activity can not be supposed. The form of nuclei, as every microscopist knows, varies infinitely, and there are numerous living organisms in which the nuclear matter is without form, appearing simply as granules distributed in the protoplasm. Not that the form assumed and the transformations undergone by the nucleus are without importance; but it is none the less true that even in an amorphous condition the material which in the ordinary cell takes the form of a "nucleus" may, in simpler organisms which have not in the process of evolution become complete cells, fulfil functions in many respects similar to those fulfilled by the nucleus of the more differentiated organism.

A similar anticipation regarding the probability of eventual synthetic production may be made for the proteins of the cell-substance. Considerable progress in this direction has indeed already been made by Emil Fischer, who has for many years been engaged in the task of building up the nitrogenous combinations which enter into the formation of the complex molecule of protein. It is satisfactory to know that the significance of the work both of Fischer and of Kossel in this field of biological chemistry has been recognized by the award to each of these distinguished chemists of a Nobel prize.

The elements composing living substance are few in number. Those which are constantly present are carbon, hydrogen, oxygen and nitrogen. With these, both in nuclear matter and also, but to a less degree, in the more diffuse living material which we know as protoplasm, phosphorus is always associated. "Ohne Phosphor kein Gedank" is an accepted aphorism; "Ohne Phosphor kein Leben" is equally true. Moreover, a large proportion, rarely less than 70 per cent., of water appears essential for any manifestation of life, although not in all cases necessary for its continuance, since organisms are known which will bear the loss of the greater part if not the whole of the water they contain without permanent impairment of their vitality. The presence of certain inorganic salts is no less essential, chief amongst them being chloride of sodium and salts of calcium, magnesium, potassium and iron. The combination of these elements into a colloidal compound represents the chemical basis of life; and when the chemist succeeds in building up this compound it will without doubt be found to exhibit the phenomena which we are in the habit of associating with the term "life."

The above considerations seem to point to the conclusion that the possibility of the production of life—*i. e.*, of living material—is not so remote as has been generally assumed. Since the experiments of Pasteur, few have ventured to affirm a belief in the spontaneous generation of bacteria and monads and other microorganisms, although before his time this was by many believed to be of universal occurrence. My esteemed friend Dr. Charlton Bastian is, so far as I am aware, the only scientific man of eminence who still adheres to the old creed, and Dr. Bastian, in spite of numerous experiments and the publication of many books and papers, has not hitherto succeeded in winning over any converts to his opinion. I am myself so entirely convinced of the accuracy of the results which Pasteur obtained—are they not within the daily and hourly experience of every one who deals with the sterilization of organic solutions?—that I do not hesitate to believe, if living torulæ or mycelia are exhibited to me in flasks which had been subjected to prolonged boiliug after being hermetically sealed, that there has been some fallacy either in the premisses or in the carrying out of the operation. The appearance of organisms in such flasks would not furnish to my mind proof that they were the result of spontaneous generation. Assuming no fault in manipulation or fallacy in observation, I should find it simpler to believe that the germs of such organisms have resisted the effects of prolonged heat than that they became generated spontaneously. If spontaneous generation is possible, we can not expect it to take the form of living beings which show so marked a degree of differentiation, both structural and functional, as the organisms which are described as making their appearance in these experimental flasks. Nor should we expect the spontaneous generation of living substance of any kind to occur in a fluid the organic constituents of which have been so altered by heat that they can retain no sort of chemical resemblance to the organic constitutents of living matter. If the formation of life—of living substance

—is possible at the present day—and for my own part I see no reason to doubt it—a boiled infusion of organic matter—and still less of inorganic matter—is the last place in which to look for it. Our mistrust of such evidence as has yet been brought forward need not, however, preclude us from admitting the possibility of the formation of living from non-living substance.

Setting aside, as devoid of scientific foundation, the idea of immediate supernatural intervention in the first production of life, we are not only justified in believing, but compelled to believe, that living matter must have owed its origin to causes similar in character to those which have been instrumental in producing all other forms of matter in the universe; in other words, to a process of gradual evolution. But it has been customary of late amongst biologists to shelve the investigation of the mode of origin of life by evolution from non-living matter by relegating its solution to some former condition of the earth's history, when, it is assumed, opportunities were accidentally favorable for the passage of inanimate matter into animate; such opportunities, it is also assumed, having never since recurred and being never likely to recur.

Various eminent scientific men have even supposed that life has not actually originated upon our globe, but has been brought to it from another planet or from another stellar system. Some of my audience may still remember the controversy that was excited when the theory of the origin of terrestrial life by the intermediation of a meteorite was propounded by Sir William Thomson in his presidential address at the meeting of this association in Edinburgh in 1871. To this "meteorite" theory the apparently fatal objection was raised that it would take some sixty million years for a meteorite to travel from the nearest stellar system to our earth, and it is inconceivable that any kind of life could be maintained during such a period. Even from the nearest planet one hundred and fifty years would be necessary, and the heating of the meteorite in passing through our atmosphere and at its impact with the earth would, in all probability, destroy any life which might have existed within it. A cognate theory, that of *cosmic panspermia,* assumes that life may exist and may have existed indefinitely in cosmic dust in the interstellar spaces (Richter, 1865; Cohn, 1872), and may with this dust fall slowly to the earth without undergoing the heating which is experienced by a meteorite. Arrhenius, who adopts this theory, states that if living germs were carried through the ether by luminous and other radiations the time necessary for their transportation from our globe to the nearest stellar system would be only nine thousand years, and to Mars only twenty days!

But the acceptance of such theories of the arrival of life on the earth does not bring us any nearer to a conception of its actual mode of origin; on the contrary it merely serves to banish the investigation of the question to some conveniently inaccessible corner of the universe and leaves us in the unsatisfactory position of affirming not only that we have no knowledge as to the mode of origin of life—which is unfortunately true—but that we never can acquire such knowledge—which it is to be hoped is not true. Knowing what we know, and believing what we believe, as to the part played by evolution in the development of terrestrial matter, we are, I think (without denying the possibility of the existence of life in other parts of the universe), justified in regarding these cosmic theories as inherently improbable—at least in comparison with the solution of the problem which the evolutionary hypothesis offers.

I assume that the majority of my audience have at least a general idea of the scope of this hypothesis, the general acceptance of which has within the last sixty years altered the whole aspect not only of biology, but of every other branch of natural science, including astronomy, geology, physics and chemistry. To those who have not this familiarity I would recommend the perusal of a little book by Professor Judd entitled "The Coming of Evolution," which has recently appeared as one of the Cambridge manuals. I know of no similar book in which the subject is as clearly and succinctly treated. Although the author nowhere expresses the opinion that the actual origin of life on the earth has arisen by evolution from non-living matter, it is impossible to read either this or any similar exposition in which the essential unity of the evolutionary process is insisted upon without concluding that the origin of life must have been due to the same process, this process being, without exception, continuous, and admitting of no gap at any part of its course. Looking therefore at the evolution of living matter by the light which is shed upon it from the study of the evolution of matter in general, we are led to regard it as having been produced, not by a sudden alteration, whether exerted by natural or supernatural agency, but by a gradual process of change from material which was lifeless, through material on the borderland between inanimate and animate, to material which has all the characteristics to which we attach the term "life." So far from expecting a sudden leap from an inorganic, or at least an unorganized, into an organic and organized condition, from an entirely inanimate substance to a completely animate state of being, should we not rather expect a gradual procession of changes from inorganic to organic matter, through stages of gradually increasing complexity until material which can be termed living is attained? And in place of looking for the production of fully formed living organisms in hermetically sealed flasks, should we not rather search nature herself, under natural conditions, for evidence of the existence, either in the past or in the present, of transitional forms between living and non-living matter?

The difficulty, nay the impossibility, of obtaining evidence of such evolution from the past history of the globe is obvious. Both the hypothetical transitional material and the living material which was originally evolved from it may, as Macallum has suggested, have taken the form of diffused ultra-microscopic particles of living substance; and even if they were not diffused but aggregated into masses, these masses could have been physically nothing more than colloidal watery slime which would leave no impress upon any geological formation. Myriads of years may have elapsed before some sort of skeleton in the shape of calcareous or siliceous spicules began to evolve itself, and thus enabled "life," which must already have possessed a prolonged existence, to make any sort of geological record. It follows that in attempting to pursue the evolution of living matter to its beginning in terrestrial history we can only expect to be confronted with a blank wall of nescience.

The problem would appear to be hopeless of ultimate solution, if we are rigidly confined to the supposition that the evolution of life has only occurred once in the past history of the globe. But are we justified in assuming that at one period only, and as it were by a fortunate and fortuitous concomitation of substance and circumstance, living matter became evolved out of non-living matter—life became established? Is there any valid reason to conclude that at some previous period of its history our earth was more favorably circumstanced for the production of life than it is now? I have vainly sought for such reason, and if none be forthcoming the conclusion forces itself upon us that the evolution of non-living into living substance has happened more than once—and we can be by no means sure that it may not be happening still.

It is true that up to the present there is no evidence of such happening: no process of transition has hitherto been observed. But on the other hand, is it not equally true that the kind of evidence which would be of any real value in determining this question has not hitherto been looked for? We may be certain that if life is being produced from non-living substance it will be life of a far simpler character than any that has yet been observed—in material which we shall be uncertain whether to call animate or inanimate, even if we are able to detect it at all, and which we may not be able to visualize physically even after we have become convinced of its existence. But we can look with the mind's eye and follow in imagination the transformation which non-living matter may have undergone and may still be undergoing to produce living substance. No principle of evolution is better founded than that insisted upon by Sir Charles Lyell, justly termed by Huxley "the greatest geologist of his time," that we must interpret the past history of our globe by the present; that we must seek for an explanation of what has happened by the study of what is happening; that, given similar circumstances, what has occurred at one time will probably occur at another. The process of evolution is universal. The inorganic materials of the globe are continually undergoing transition. New chemical combinations are constantly being formed and old ones broken up; new elements are making their appearance and old elements disappearing. Well may we ask ourselves why the production of living matter alone should be subject to other laws than those which have produced, and are producing, the various forms of non-living matter; why what has happened may not happen? If living matter has been evolved from lifeless in the past, we are justified in accepting the conclusion that its evolution is possible in the present and in the future. Indeed, we are not only justified in accepting this conclusion, we are forced to accept it. When or where such change from non-living to living matter may first have occurred, when or where it may have continued, when or where it may still be occurring, are problems as difficult as they are interesting, but we have no right to assume that they are insoluble.

Since living matter always contains water as its most abundant constituent, and since the first living organisms recognizable as such in the geological series were aquatic, it has generally been assumed that life must first have made its appearance in the depths of the ocean. Is it, however, certain that the assumption that life originated in the sea is correct? Is not the land-surface of our globe quite as likely to have been the nidus for the evolutionary transformation of non-living into living material as the waters which surround it? Within this soil almost any chemical transformation may occur; it is subjected much more than matters dissolved in sea-water to those fluctuations of moisture, temperature, electricity, and luminosity which are potent in producing chemical changes. But whether life, in the form of a simple slimy colloid, originated in the depths of the sea or on the surface of the land, it would be equally impossible for the geologist to trace its beginnings, and were it still becoming evolved in the same situations, it would be almost as impossible for the microscopist to follow its evolution. We are therefore not likely to obtain direct evidence regarding such a transformation of non-living into living matter in nature, even if it is occurring under our eyes.

An obvious objection to the idea that the production of living matter from non-living has happened more than once is that, had this been the case, the geological record should reveal more than one paleontological series. This objection assumes that evolution would in every case take an exactly similar course and proceed to the same goal —an assumption which is, to say the least, improbable. If, as might well be the case, in any other paleontological series than the one with which we are acquainted the process of evolution of living beings did not proceed beyond protista, there would be no obvious geological evidence regarding it; such evidence would only be discoverable by a carefully directed search made with that particular object in view. I would not by any means minimize the difficulties which attend the suggestion that the evolution of life may have occurred more than once or may still be happening, but on the other hand, it must not be ignored that those which attend the assumption that the production of life has occurred once only are equally serious. Indeed, had the idea of the possibility of a multiple evolution of living substance been first in the field, I doubt if the prevalent belief regarding a single fortuitous production of life upon the globe would have become established among biologists—so much are we liable to be influenced by the impressions we receive in scientific childhood!

Assuming the evolution of living matter to have occurred—whether once only or more frequently matters not for the moment—and in the form suggested, viz., as a mass of colloidal slime possessing the property of assimilation and therefore of growth, reproduction would follow as a matter of course. For all material of this physical nature—fluid or semi-fluid in character—has a tendency to undergo subdivision when its bulk exceeds a certain size. The subdivision may be into equal or nearly equal parts, or it may take the form of buds. In either case every separated part would resemble the parent in chemical and physical properties, and would equally possess the property of taking in and assimilating suitable material from its liquid environment, growing in bulk and reproducing its like by subdivision. *Omne vivum e vivo.* In this way from any beginning of living material a primitive form of life would spread, and would gradually people the globe. The establishment of life being once effected, all forms of organization follow under the inevitable laws of evolution. *Ce n'est que le premier pas qui coûte.*

We can trace in imagination the segregation of a more highly phosphorized portion of the primitive living matter, which we may now consider to have become more akin to the protoplasm of organisms with which we are familiar. This more phosphorized portion might not for myriads of generations take the form of a definite nucleus, but it would be composed of material having a composition and qualities similar to those of the nucleus of a cell. Prominent among these qualities is that of catalysis—the function of effecting profound chemical changes in other material in contact with it without itself undergoing permanent change. This catalytic function may have been exercised directly by the living substance or may have been carried on through the agency of the enzymes already mentioned, which are also of a colloid nature but of simpler constitution than itself, and which differ from the catalytic agents employed by the chemist in the fact that they produce their effects at a relatively low temperature. In the course of evolution special enzymes would become developed for adaptation to special conditions of life, and with the appearance of these and other modifications, a process of differentiation of primitive living matter into individuals with definite specific characters gradually became established. We can conceive of the production in this way from originally undifferentiated living substance of simple differentiated organisms comparable to the lowest forms of protista. But how long it may have taken to arrive at this stage we have no means of ascertaining. To judge from the evidence afforded by the evolution of higher organisms it would seem that a vast period of time would be necessary for even this amount of organization to establish itself.

The next important phase in the process of evolution would be the segregation and moulding of the diffused or irregularly aggregated nuclear matter into a definite nucleus around which all the chemical activity of the organism will in future be centered. Whether this change were due to a slow and gradual process of segregation or of the nature of a jump, such as nature does occasionally make, the result would be the advancement of the living organism to the condition of a complete nucleated cell: a material advance not only in organization but—still more important—in potentiality for future development. Life is now embodied in the cell, and every living being evolved from this will itself be either a cell or a cell-aggregate. *Omnis cellula e cellulâ.*

After the appearance of a nucleus—but how long after it is impossible to conjecture—another phenomenon appeared upon the scene in the occasional exchange of nuclear substance between cells. In this manner became established the process of sexual reproduction. Such exchange in the unicellular protista might and may occur between any two cells forming the species, but in the multicellular metazoa it became—like other functions—specialized in particular cells. The result of the exchange is rejuvenescence; associated with an increased tendency to subdivide and to produce new individuals. This is due to the introduction of a stimulating or catalytic chemical agent into the cell which is to be rejuvenated, as is proved by the experiments of Loeb already alluded to. It is true that the chemical material introduced into the germ-cell in the ordinary process of its fertilization by the sperm-cell is usually accompanied by the introduction of definite morphological elements which blend with others already contained within the germ-cell, and it is believed that the transmission of such morphological elements of the parental nuclei is related to the transmission of parental qualities. But we must not be blind to the possibility that these transmitted qualities may be connected with specific chemical characters of the transmitted elements; in other words, that heredity also is one of the questions the eventual solution of which we must look to the chemist to provide.

So far we have been chiefly considering life as it is found in the simplest forms of living substance, organisms for the most part entirely microscopic and neither distinctively animal nor vegetable, which were grouped together by Haeckel as a separate kingdom of animated nature—that of protista. But persons unfamilar with the microscope are not in the habit of associating the term "life" with microscopic organisms, whether these take the form of cells or of minute portions of living substance which have not yet attained to that dignity. We most of us speak and think of life as it occurs in ourselves and other animals with which we are familiar; and as we find it in the plants around us. We recognize it in these by the possession of certain properties—movement, nutrition, growth, and reproduction. We are not aware by intuition, nor can we ascertain without the employment of the miscroscope, that we and all the higher living beings, whether animal or vegetable, are entirely formed of aggregates of nucleated cells, each microscopic and each possessing its own life. Nor could we suspect by intuition that what we term our life is not a single indivisible property, capable of being blown out with a puff like the flame of a candle; but is the aggregate of the lives of many millions of living cells of which the body is composed. It is but a short while ago that this cell-constitution was discovered: it occurred within the lifetime, even within the memory, of some who are still with us. What a marvellous distance we have travelled since then in the path of knowledge of living organisms! The strides which were made in the advance of the mechanical sciences during the nineteenth century, which is generally considered to mark that century as an age of unexampled progress, are as nothing in comparison with those made in the domain of biology, and their interest is entirely dwarfed by that which is aroused by the facts relating to the phenomena of life which have accumulated within the same period. And not the least remarkable of these facts is the discovery of the cell-structure of plants and animals!

Let us consider how cell-aggregates came to be evolved from organisms consisting of single cells. Two methods are possible—viz.: (1) the adhesion of a number of originally separate individuals; (2) the subdivision of a single individual without the products of its subdivision breaking loose from one another. No doubt this last is the manner whereby the cell-aggregate was originally formed, since it is that by which it is still produced, and we know that the life-history of the individual is an epitome of that of the species. Such aggregates were in the beginning solid; the cells in contact with one another and even in continuity: subsequently a space or cavity became formed in the interior of the mass, which was thus converted into a hollow sphere. All the cells of the aggregate were at first perfectly similar in structure and in function; there was no subdivision of labor. All would take part in effecting locomotion; all would receive stimuli from outside; all would take in and digest nutrient matter, which would then be passed into the cavity of the sphere to serve as a common store of nourishment. Such organisms are still found, and constitute the lowest types of metazoa. Later one part of the hollow sphere became dimpled to form a cup; the cavity of the sphere became correspondingly altered in shape. With this change in structure differentiation of function between the cells covering the outside and those lining the inside of the cup made its appearance. Those on the outside subserved locomotor functions and received and transmitted from cell to cell stimuli, physical or chemical, received by the organism; while those on the inside, being freed from such functions, tended to specialize in the direction of the inception and digestion of nutrient material; which, passing from them into the cavity of the invaginated sphere, served for the nourishment of all the cells composing the organism. The further course of evolution produced many changes of form and ever-increasing complexity of the cavity thus produced by simple invagination. Some of the cell-aggregates settled down to a sedentary life, becoming plant-like in appearance and to some extent in habit. Such organisms, complex in form but simple in structure, are the sponges. Their several parts are not, as in the higher metazoa, closely interdependent: the destruction of any one part, however extensive, does not either immediately or ultimately involve death of the rest: all parts function separately, although doubtless mutually benefiting by their conjunction, if only by slow diffusion of nutrient fluid throughout the mass. There is already some differentiation in these organisms, but the absence of a nervous system prevents any general coordination, and the individual cells are largely independent of one another.

Our own life, like that of all the higher animals, is an *aggregate life;* the life of the whole is the life of the individual cells. The life of some of these cells can be put an end to, the rest may continue to live. This is, in fact, happening every moment of our lives. The cells which cover the surface of our body, which form the scarf-skin and the hairs and nails, are constantly dying and the dead cells are rubbed off or cut away, their place being taken by others supplied from living layers beneath. But the death of these cells does not affect the vitality of the body as a whole. They serve merely as a protection, or an ornamental covering, but are otherwise not material to our existence. On the other hand, if a few cells, such as those nerve-cells under the influence of which respiration is carried on, are destroyed or injured, within a minute or two the whole living machine comes to a standstill, so that to the bystander the patient is dead; even the doctor will pronounce life to be extinct. But this pronouncement is correct only in a special sense. What has happened is that, owing to the cessation of respiration, the supply of oxygen to the tissues is cut off. And since the manifestations of life cease without this supply, the animal or patient appears to be dead. If, however, within a short period we supply the needed oxygen to the tissues requiring it, all the manifestations of life reappear.

It is only some cells which lose their vitality at the moment of so-called "general death." Many cells of the body retain their individual life under suitable circumstances long after the rest of the body is dead. Notable among these are muscle-cells. McWilliam showed that the muscle-cells of the blood-vessels give indications of life several days after an animal has been killed. The muscle-cells of the heart in mammals have been revived and caused to beat regularly and strongly many hours after apparent death. In man this result has been obtained by Kuliabko as many as eighteen hours after life had been pronounced extinct: in animals after days had elapsed. Waller has shown that indications of life can be elicited from various tissues many hours and even days after general death. Sherrington observed the white corpuscles of the blood to be active when kept in a suitable nutrient fluid weeks after removal from the blood-vessels. A French histologist, Jolly, has found that the white corpuscles of the frog, if kept in a cool place and under suitable conditions, show at the end of a year all the ordinary manifestations of life. Carrel and Burrows have observed activity and growth to continue for long periods in the isolated cells of a number of tissues and organs kept under observation in a suitable medium. Carrel has succeeded in substituting entire organs obtained after death from one animal for those of another of the same species, and has thereby opened up a field of surgical treatment the limit of which can not yet be descried. It is a well-established fact that any part or organ of the body can be maintained alive for hours isolated from the rest if the blood-vessels are perfused with an oxygenated solution of salts in certain proportions (Ringer). Such revival and prolongation of the life of separated organs is an ordinary procedure in laboratories of physiology. Like all the other instances enumerated, it is based on the fact that the individual cells of an organ have a life of their own which is largely independent, so that they will continue in suitable circumstances to live, although the rest of the body to which they belonged may be dead.

But some cells, and the organs which are formed of them, are more necessary to maintain the life of the aggregate than others, on account of the nature of the functions which have become specialized in them. This is the case with the nerve-cells of the respiratory center, since they preside over the movements which are necessary to effect oxygenation of the blood. It is also true for the cells which compose the heart, since this serves to pump oxygenated blood to all other cells of the body: without such blood most cells soon cease to live. Hence we examine respiration and heart to determine if life is present: when one or both of these are at a standstill we know that life can not be maintained. These are not the only organs necessary for the maintenance of life, but the loss of others can be borne longer, since the functions which they subserve, although useful or even essential to the organism, can be dispensed with for a time. The life of some cells is therefore more, of others less, necessary for maintaining the life of the rest. On the other hand, the cells composing certain organs have in the course of evolution ceased to be necessary, and their continued existence may even be harmful. Wiedersheim has enumerated more than a hundred of these organs in the human body. Doubtless nature is doing her best to get rid of them for us, and our descendants will some day have ceased to possess a vermiform appendix or a pharyngeal tonsil: until that epoch arrives we must rely for their removal on the more rapid methods of surgery!

We have seen that in the simplest multicellular organisms, where one cell of the aggregate differs but little from another, the conditions for the maintenance of the life of the whole are nearly as simple as those for individual cells. But the life of a cell-aggregate such as composes the bodies of the higher animals is maintained not only by the conditions for the maintenance of the life of the individual cell being kept favorable, but also by the coordination of the varied activities of the cells which form the aggregate. Whereas in the lowest metazoa all cells of the aggregate are alike in structure and function and perform and share everything in common, in higher animals (and for that matter in the higher plants also) the cells have become specialized, and each is only adapted for the performance of a particular function. Thus the cells of the gastric glands are only adapted for the secretion of gastric juice, the cells of the villi for the absorption of digested matters from the intestine, the cells of the kidney for the removal of waste products and superfluous water from the blood, those of the heart for pumping blood through the vessels. Each of these cells has its individual life and performs its individual functions. But unless there were some sort of cooperation and subordination to the needs of the body generally, there would be sometimes too little, sometimes too much gastric juice secreted; sometimes too tardy, sometimes too rapid an absorption from the intestine; sometimes too little, sometimes too much blood pumped into the arteries, and so on. As the result of such lack of cooperation the life of the whole would cease to be normal and would eventually cease to be maintained.

We have already seen what are the conditions which are favorable for the maintenance of life of the individual cell, no matter where situated. The principal condition is that it must be bathed by a nutrient fluid of suitable and constant composition. In higher animals this fluid is the lymph, which bathes the tissue elements and is itself constantly supplied with fresh nutriment and oxygen by the blood. Some tissue-cells are directly bathed by blood; and in invertebrates, in which there is no special system of lymph-vessels, all the tissues are thus nourished. All cells both take from and give to the blood, but not the same materials or to an equal extent. Some, such as the absorbing cells of the villi, almost exclusively give; others, such as the cells of the renal tubules, almost exclusively take. Nevertheless, the resultant of all the give and take throughout the body serves to maintain the composition of the blood constant under all circumstances. In this way the first condition of the maintenance of the life of the aggregate is fulfilled by insuring that the life of the individual cells composing it is kept normal.

The second essential condition for the maintenance of life of the cell-aggregate is the coordination of its parts and the due regulation of their activity, so that they may work together for the benefit of the whole. In the animal body this is effected in two ways: first, through the nervous system; and second, by the action of specific chemical substances which are formed in certain organs and carried by the blood to other parts of the body, the cells of which they excite to activity. These substances have received the general designation of "hormones" (ὁρμάω, to stir up) a term introduced by Professor Starling. Their action, and indeed their very existence, has only been recognized of late years, although the part which they play in the physiology of animals appears to be only second in importance to that of the nervous system itself; indeed, maintenance of life may become impossible in the absence of certain of these hormones.

Before we consider the manner in which the nervous system serves to coordinate the life of the cell-aggregate, let us see how it has become evolved.

The first step in the process was taken when certain of the cells of the external layer became specially sensitive to stimuli from outside, whether caused by mechanical impressions (tactile and auditory stimuli) or impressions of light and darkness (visual stimuli) or chemical impressions. The effects of such impressions were probably at first simply communicated to adjacent cells and spread from cell to cell throughout the mass. An advance was made when the more impressionable cells threw out branching feelers amongst the other cells of the organism. Such feelers would convey the effects of stimuli with greater rapidity and directness to distant parts. They may at first have been retractile, in this respect resembling the long pseudopodia of certain rhizopoda. When they became fixed they would be potential nerve-fibers and would represent the beginning of a nervous system. Even yet (as Ross Harrison has shown), in the course of development of nerve-fibers, each fiber makes its appearance as an amœboid cell-process which is at first retractile, but gradually grows into the position it is eventually to occupy and in which it will become fixed.

In the further course of evolution a certain number of these specialized cells of the external layer sank below the general surface, partly perhaps for protection, partly for better nutrition: they became nerve-cells. They remained connected with the surface by a prolongation which became an afferent or sensory nerve-fiber, and through its termination between the cells of the general surface continued to receive the effects of external impressions; on the other hand, they continued to transmit these impressions to other, more distant cells by their efferent prolongations. In the further course of evolution the nervous system thus laid down became differentiated into distinct *afferent, efferent* and *intermediary* portions. Once established, such a nervous system, however simple, must dominate the organism, since it would furnish a mechanism whereby the individual cells would work together more effectually for the mutual benefit of the whole.

It is the development of the nervous system, although not proceeding in all classes along exactly the same lines, which is the most prominent feature of the evolution of the metazoa. By and through it all impressions reaching the organism from the outside are translated into contraction or some other form of cell-activity. Its formation has been the means of causing the complete divergence of the world of animals from the world of plants, none of which possess any trace of a nervous system. Plants react, it is true, to external impressions, and these impressions produce profound changes and even comparatively rapid and energetic movements in parts distant from the point of application of the stimulus—as in the well-known instance of the sensitive plant. But the impressions are in all cases propagated directly from cell to cell—not through the agency of nerve-fibers; and in the absence of anything corresponding to a nervous system it is not possible to suppose that any plant can ever acquire the least glimmer of intelligence. In animals, on the other hand, from a slight original modification of certain cells has directly proceeded in the course of evolution the elaborate structure of the nervous system with all its varied and complex functions, which reach their culmination in the workings of the human intellect. "What a piece of work is a man! How noble in reason! How infinite in faculty! In form and moving how express and admirable! In action how like an angel! In apprehension how like a god!" But lest he be elated with his psychical achievements, let him remember that they are but the result of the acquisition by a few cells in a remote ancestor of a slightly greater tendency to react to an external stimulus, so that these cells were brought into closer touch with the outer world; while on the other hand, by extending beyond the circumscribed area to which their neighbors remained restricted, they gradually acquired a dominating influence over the rest. These dominating cells became nerve-cells; and now not only furnish the means for transmission of impressions from one part of the organism to another, but in the progress of time have become the seat of perception and conscious sensation, of the formation and association of ideas, of memory, volition and all the manifestations of the mind!

The most conspicuous part played by the nervous system in the phenomena of life is that which produces and regulates the general movements of the body—movements brought about by the so-called voluntary muscles. These movements are actually the result of impressions imparted to sensory or afferent nerves at the periphery—*e. g.*, in the skin or in the several organs of special sense; the effect of these impressions may not be immediate, but can be stored for an indefinite time in certain cells of the nervous system. The regulation of movements—whether they occur instantly after reception of the peripheral impression or result after a certain lapse of time; whether they are accompanied by conscious sensation or are of a purely reflex and unconscious character—is an intricate process, and the conditions of their coordination are of a complex nature involving not merely the causation of contraction of certain muscles, but also the prevention of contraction of others. For our present knowledge of these conditions we are largely indebted to the researches of Professor Sherrington.

A less conspicuous but no less important part played by the nervous system is that by which the contractions of involuntary muscles are regulated. Under normal circumstances these are always independent of consciousness, but their regulation is brought about in much the same way as is that of the contractions of voluntary muscles—viz., as the result of impressions received at the periphery. These are transmitted by afferent fibers to the central nervous system, and from the latter other impulses are sent down, mostly along the nerves of the sympathetic or autonomic system of nerves, which either stimulate or prevent contraction of the involuntary muscles. Many involuntary muscles have a natural tendency to continuous or rhythmic contraction which is quite independent of the central nervous system; in this case the effect of impulses received from the latter is merely to increase or diminish the amount of such contraction. An example of this double effect is observed in connection with the heart, which —although it can contract regularly and rhythmically when cut off from the nervous system and even if removed from the body —is normally stimulated to increased activity by impulses coming from the central nervous system through the sympathetic, or to diminished activity by others coming through the vagus. It is due to the readiness by which the action of the heart is influenced in these opposite ways by the spread of impulses generated during the nerve-storms which we term "emotions" that in the language of poetry, and even of every day, the word "heart" has become synonymous with the emotions themselves.

The involuntary muscle of the arteries has its action similarly balanced. When its contraction is increased, the size of the vessels is lessened and they deliver less blood; the parts they supply accordingly become pale in color. On the other hand, when the contraction is diminished the vessels enlarge and deliver more blood; the parts which they supply become correspondingly ruddy. These changes in the arteries, like the effects upon the heart, may also be produced under the influence of emotions. Thus "blushing" is a purely physiological phenomenon due to diminished action of the muscular tissue of the arteries, whilst the pallor produced by fright is caused by an increased contraction of that tissue. Apart, however, from these conspicuous effects, there is constantly proceeding a less apparent but not less important balancing action between the two sets of nerve-fibers distributed to heart and blood-vessels; which are influenced in one direction or another by every sensation which we experience and even by impressions of which we may be wholly unconscious, such as those which occur during sleep or anesthesia, or which affect our otherwise insensitive internal organs.

A further instance of nerve-regulation is seen in secreting glands. Not all glands are thus regulated, at least not directly;

but in those which are, the effects are striking. Their regulation is of the same general nature as that exercised upon involuntary muscle, but it influences the chemical activities of the gland-cells and the outpouring of secretion from them. By means of this regulation a secretion can be produced or arrested, increased or diminished. As with muscle, a suitable balance is in this way maintained, and the activity of the glands is adapted to the requirements of the organism. Most of the digestive glands are thus influenced, as are the skin-glands which secrete sweat. And by the action of the nervous system upon the skin-glands, together with its effect in increasing or diminishing the blood-supply to the cutaneous blood-vessels, the temperature of our blood is regulated and is kept at the point best suited for maintenance of the life and activity of the tissues.

The action of the nervous system upon the secretion of glands is strikingly exemplified, as in the case of its action upon the heart and blood-vessels by the effects of the emotions. Thus an emotion of one kind—such as the anticipation of food—will cause saliva to flow—"the mouth to water"; whereas an emotion of another kind—such as fear or anxiety—will stop the secretion, causing the "tongue to cleave unto the roof of the mouth," and rendering speech difficult or impossible. Such arrest of the salivary secretion also makes the swallowing of dry food difficult: advantage of this fact is taken in the "ordeal by rice" which used to be employed in the east for the detection of criminals.

The activities of the cells constituting our bodies are controlled, as already mentioned, in another way than through the nervous system, viz., by chemical agents (hormones) circulating in the blood. Many of these are produced by special glandular organs, known as internally secreting glands. The ordinary secreting glands pour their secretions on the exterior of the body or on a surface communicating with the exterior; the internally secreting glands pass the materials which they produce directly into the blood. In this fluid the hormones are carried to distant organs. Their influence upon an organ may be essential to the proper performance of its functions or may be merely ancillary to it. In the former case removal of the internally secreting gland which produces the hormone, or its destruction by disease, may prove fatal to the organism. This is the case with the suprarenal capsules: small glands which are adjacent to the kidneys, although having no physiological connection with these organs. A Guy's physician, Dr. Addison, in the middle of the last century showed that a certain affection, almost always fatal, since known by his name, is associated with disease of the suprarenal capsules. A short time after this observation a French physiologist, Brown-Séquard, found that animals from which the suprarenal capsules are removed rarely survive the operation for more than a few days. In the concluding decade of the last century interest in these bodies was revived by the discovery that they are constantly yielding to the blood a chemical agent (or hormone) which stimulates the contractions of the heart and arteries and assists in the promotion of every action which is brought about through the sympathetic nervous system (Langley). In this manner the importance of their integrity has been explained, although we have still much to learn regarding their functions.

Another instance of an internally secreting gland which is essential to life, or at least to its maintenance in a normal condition, is the thyroid. The association of imperfect development or disease of the thyroid with disorders of nutrition and inactivity of the nervous system is well ascertained. The form of idiocy known as cretinism and the affection termed myxœdema are both associated with deficiency of its secretion: somewhat similar conditions to these are produced by the surgical removal of the gland. The symptoms are alleviated or cured by the administration of its juice. On the other hand, enlargement of the thyroid, accompanied by increase of its secretion, produces symptoms of nervous excitation, and similar symptoms are caused by excessive administration of the glandular substance by the mouth. From these observations it is inferred that the juice contains hormones which help to regulate the nutrition of the body and serve to stimulate the nervous system, for the higher functions of which they appear to be essential. To quote M. Gley, to whose researches we owe much of our knowledge regarding the functions of this organ: "La genèse et l'exercice des plus hautes facultés de l'homme sont conditionnés par l'action purement chimique d'un produit de sécrétion. Que les psychologues méditent ces faits!"

The case of the parathyroid glandules is still more remarkable. These organs were discovered by Sandström in 1880. They are four minute bodies, each no larger than a pin's head, imbedded in the thyroid. Small as they are, their internal secretion possesses hormones which exert a powerful influence upon the nervous system. If they are completely removed, a complex of symptoms, technically known as "tetany," is liable to occur, which is always serious and may be fatal. Like the hormones of the thyroid itself, therefore, those of the parathyroids produce effects upon the nervous system, to which they are carried by the blood; although the effects are of a different kind.

Another internally secreting gland which has evoked considerable interest during the last few years is the pituitary body. This is a small structure no larger than a cobnut attached to the base of the brain. It is mainly composed of glandular cells. Its removal has been found (by most observers) to be fatal—often within two or three days. Its hypertrophy, when occurring during the general growth of the body, is attended by an undue development of the skeleton, so that the stature tends to assume gigantic proportions. When the hypertrophy occurs after growth is completed, the extremities—viz., the hands and feet, and the bones of the face—are mainly affected; hence the condition has been termed "acromegaly" (enlargement of extremities). The association of this condition with affections of the pituitary was pointed out in 1885 by a distinguished French physician, Dr. Pierre Marie. Both "giants" and "acromegalists" are almost invariably found to have an enlarged pituitary. The enlargement is generally confined to one part—the anterior lobe —and we conclude that this produces hormones which stimulate the growth of the body generally and of the skeleton in particular. The remainder of the pituitary is different in structure from the anterior lobe and has a different function. From it hormones can be extracted which, like those of the suprarenal capsule, although not exactly in the same manner, influence the contraction of the heart and arteries. Its extracts are also instrumental in promoting the secretion of certain glands. When injected into the blood they cause a free secretion of water from the kidneys and of milk from the mammary glands, neither of which organs are directly influenced (as most other glands are) through the nervous system. Doubtless under natural conditions these organs are stimulated to activity by hormones which are produced in the pituitary and which pass from this into the blood.

The internally secreting glands which have been mentioned (thyroid, parathyroid, suprarenal, pituitary) have, so far as is known, no other function than that of producing chemical substances of this character for the influencing of other organs, to which they are conveyed by the blood. It is interesting to observe that these glands are all of very small size, none being larger than a walnut, and some—the parathyroids—almost microscopic. In spite of this, they are essential to the proper maintenance of the life of the body, and the total removal of any of them by disease or operations is in most cases speedily fatal.

There are, however, organs in the body yielding internal secretions to the blood in the shape of hormones, but exercising at the same time other functions. A striking instance is furnished by the pancreas, the secretion of which is the most important of the digestive juices. This—the pancreatic juice—forms the external secretion of the gland, and is poured into the intestine, where its action upon the food as it passes out from the stomach has long been recognized. It was, however, discovered in 1889 by von Mering and Minkowski that the pancreas also furnishes an internal secretion, containing a hormone which is passed from the pancreas into the blood, by which it is carried first to the liver and afterwards to the body generally. This hormone is essential to the proper utilization of carbohydrates in the organism. It is well known that the carbohydrates of the food are converted into grape sugar and circulate in this form in the blood, which always contains a certain amount; the blood conveys it to all the cells of the body, and they utilize it as fuel. If, owing to disease of the pancreas or as the result of its removal by surgical procedure, its internal secretion is not available, sugar is no longer properly utilized by the cells of the body and tends to accumulate in the blood; from the blood the excess passes off by the kidneys, producing diabetes.

Another instance of an internal secretion furnished by an organ which is devoted largely to other functions is the "pro-secretin" found in the cells lining the duodenum. When the acid gastric juice comes into contact with these cells it converts their pro-secretin into "secretin." This is a hormone which is passed into the blood and circulates with that fluid. It has a specific effect on the externally secreting cells of the pancreas, and causes the rapid outpouring of pancreatic juice into the intestine. This effect is similar to that of the hormones of the pituitary body upon the cells of the kidney and mammary gland. It was discovered by Bayliss and Starling.

The reproductive glands furnish in many respects the most interesting example of organs which—besides their ordinary products, the germ- and sperm-cells (ova and spermatozoa)—form hormones which circulate in the blood and effect changes in cells of distant parts of the body. It is through these hormones that the secondary sexual characters, such as the comb and tail of the cock, the mane of the lion, the horns of the stag, the beard and enlarged larynx of a man, are produced, as well as the many differences in form and structure of the body which are characteristic of the sexes. The dependence of these so-called secondary sexual characters upon the state of development of the reproductive organs has been recognized from time immemorial, but has usually been ascribed to influences produced through the nervous system, and it is only in recent years that the changes have been shown to be brought about by the agency of internal secretions and hormones, passed from the reproductive glands into the circulating blood.

It has been possible in only one or two instances to prepare and isolate the hormones of the internal secretions in a sufficient condition of purity to subject them to analysis, but enough is known about them to indicate that they are organic bodies of a not very complex nature, far simpler than proteins and even than enzymes. Those which have been studied are all dialysable are readily soluble in water but insoluble in alcohol, and are not destroyed by boiling. One at least—that of the medulla of the suprarenal capsule—has been prepared synthetically, and when their exact chemical nature has been somewhat better elucidated it will probably not be difficult to obtain others in the same way.

From the above it is clear that not only is a coordination through the nervous system necessary in order that life shall be maintained in a normal condition, but a chemical coordination is no less essential. These may be independent of one another; but on the other hand they may react upon one another. For it can be shown that the production of some at least of the hormones is under the influence of the nervous system (Biedl, Asher, Elliott); whilst, as we have seen, some of the functions of the nervous system are dependent upon hormones.

Time will not permit me to refer in any but the briefest manner to the protective mechanisms which the cell aggregate has evolved for its defence against disease, especially disease produced by parasitic microorganisms. These, which belong with few exceptions to the protista, are without doubt the most formidable enemies which the multicellular metazoa, to which all the higher animal organisms belong, have to contend against. To such microorganisms are due *inter alia* all diseases which are liable to become epidemic, such as anthrax and rinderpest in cattle, distemper in dogs and cats, small-pox, scarlet fever, measles, and sleeping sickness in man. The advances of modern medicine have shown that the symptoms of these diseases—the disturbances of nutrition, the temperature, the lassitude or excitement, and other nervous disturbances—are the effects of chemical poisons (*toxins*) produced by the microorganisms and acting deleteriously upon the tissues of the body. The tissues, on the other hand, endeavor to counteract these effects by producing other chemical substances destructive to the microorganisms or antagonistic to their action: these are known as *anti-bodies.* Sometimes the protection takes the form of a subtle alteration in the living substance of the cells which renders them for a long time, or even permanently, insusceptible (immune) to the action of the poison. Sometimes certain cells of the body, such as the white corpuscles of the blood, eat the invading microorganisms and destroy them bodily by the action of chemical agents within their protoplasm. The result of an illness thus depends upon the result of the struggle between these opposing forces—the microorganisms on the one hand and the cells of the body on the other—both of which fight with chemical weapons. If the cells of the body do not succeed in destroying the invading organisms it is certain that the invaders will in the long run destroy them, for in this combat no quarter is given. Fortunately we have been able, by the aid of animal experimentation, to acquire some knowledge of the manner in which we are attacked by microorganisms and of the methods which the cells of our body adopt to repel the attack, and the knowledge is now extensively utilized to assist our defence. For this purpose protective serums or antitoxins, which have been formed in the blood of other animals, are employed to supplement the action of those which our own cells produce. It is not too much to assert that the knowledge of the parasitic origin of so many diseases and of the chemical agents which on the one hand cause, and on the other combat, their symptoms, has transformed medicine from a mere art practised empirically, into a real science based upon experiment. The transformation has opened out an illimitable vista of possibilities in the direction not only of cure, but, more important still, of prevention. It has taken place within the memory of most of us who are here present. And only last February the world was mourning the death of one of the greatest of its benefactors—a former president of this association—who, by applying this knowledge to the practise of surgery, was instrumental, even in his own lifetime, in saving more lives than were destroyed in all the bloody wars of the nineteenth century!

The question has been debated whether, if all accidental modes of destruction of the life of the cell could be eliminated, there would remain a possibility of individual cell-life, and even of aggregate cell-life, continuing indefinitely; in other words, Are the phenomena of senescence and death a natural and necessary sequence to the existence of life? To most of my audience it will appear that the subject is not open to debate. But some physiologists (*e. g.*, Metchnikoff) hold that the condition of senescence is itself abnormal; that old age is a form of disease or is due to disease, and, theoretically at least, is capable of being eliminated. We have already seen that individual cell-life, such as that of the white blood-corpuscles and of the cells of many tissues, can under suitable conditions be prolonged for days or weeks or months after general death. Unicellular organisms kept under suitable conditions of nutrition have been observed to carry on their functions normally for prolonged periods and to show no degeneration such as would accompany senescence. They give rise by division to others of the same kind, which also, under favorable conditions, continue to live, to all appearance indefinitely. But these instances, although they indicate that in the simplest forms of organization existence may be greatly extended without signs of decay, do not furnish conclusive evidence of indefinite prolongation of life. Most of the cells which constitute the body, after a period of growth and activity, sometimes more, sometimes less prolonged, eventually undergo atrophy and cease to perform satisfactorily the functions which are allotted to them. And when we consider the body, as a whole, we find that in every case the life of the aggregate consists of a definite cycle of changes which, after passing through the stages of growth and maturity, always leads to senescence, and finally terminates in death. The only exception is in the reproductive cells, in which the processes of maturation and fertilization result in rejuvenescence, so that instead of the usual downward change towards senescence, the fertilized ovum obtains a new lease of life, which is carried on into the new-formed organism. The latter again itself ultimately forms reproductive cells, and thus the life of the species is continued. It is only in the sense of its propagation in this way from one generation to another that we can speak of the indefinite continuance of life: we can only be immortal through our descendants!

The individuals of every species of animal appear to have an average duration of existence. Some species are known the individuals of which live only for a few hours, whilst others survive for a hundred years. In man himself the average length of life would probably be greater than the three-score and ten years allotted to him by the Psalmist if we could eliminate the results of disease and accident; when these results are included it falls far short of that period. If the terms of life given in the purely mythological part of the old testament were credible, man would in the early stages of his history have possessed a remarkable power of resisting age and disease. But, although many here present were brought up to believe in their literal veracity, such records are no longer accepted even by the most orthodox of theologians, and the nine hundred odd years with which Adam and his immediate descendants are credited, culminating in the nine hundred and sixty-nine of Methuselah, have been relegated, with the account of creation and the deluge, to their proper position in literature. When we come to the Hebrew patriarchs, we notice a considerable diminution to have taken place in what the insurance offices term the "expectation of life." Abraham is described as having lived only to 175 years, Joseph and Joshua to 110, Moses to 120; even at that age "his eye was not dim nor his natural force abated." We can not say that under ideal conditions all these terms are impossible; indeed, Metchnikoff is disposed to regard them as probable; for great ages are still occasionally recorded, although it is doubtful if any as considerable as these are ever substantiated. That the expectation of life was better then than now would be inferred from the apologetic tone adopted by Jacob when questioned by Pharaoh as to his age: "The days of the years of my pilgrimage are a hundred and thirty years; few and evil have the days of the years of my life been, and have not attained unto the days of the years of the life of my fathers in the days of their pilgrimage." David, to whom, before the advent of the modern statistician, we owe the idea that seventy years is to be regarded as the normal period of life, is himself merely stated to have "died in a good old age." The periods recorded for the kings show a considerable falling-off as compared with the patriarchs; but not a few were cut off by violent deaths, and many lived lives which were not ideal. Amongst eminent Greeks and Romans few very long lives are recorded, and the same is true of historical persons in mediæval and modern history. It is a long life that lasts much beyond eighty; three such linked together carry us far back into history. Mankind is in this respect more favored than most mammals, although a few of these surpass the period of man's existence. Strange that the brevity of human life should be a favorite theme of preacher and poet when the actual term of his "erring pilgrimage" is greater than that of most of his fellow creatures!

The modern applications of the principles of preventive medicine and hygiene are no doubt operating to lengthen the average life. But even if the ravages of disease could be altogether eliminated, it is certain that at any rate the fixed cells of our body must eventually grow old and ultimately cease to function; when this happens to cells which are essential to the life of the organism, general death must result. This will always remain the universal law, from which there is no escape. "All that lives must die, passing through nature to eternity."

Such natural death unaccelerated by disease—is not death by disease as unnatural as death by accident?—should be a quiet, painless phenomenon, unattended by violent change. As Dastre expresses it, "The need of death should appear at the end of life, just as the need of sleep appears at the end of the day." The change has been led gradually up to by an orderly succession of phases, and is itself the last manifestation of life. Were we all certain of a quiet passing—were we sure that there would be "no moaning of the bar when we go out to sea"—we could anticipate the coming of death after a ripe old age without apprehension. And if ever the time shall arrive when man will have learned to regard this change as a simple physiological process, as natural as the oncoming of sleep, the approach of the fatal shears will be as generally welcomed as it is now abhorred. Such a day is still distant; we can hardly say that its dawning is visible. Let us at least hope that, in the manner depicted by Dürer in his well-known etching, the sunshine which science irradiates may eventually put to flight the melancholy which hovers, bat-like, over the termination of our lives, and which even the anticipation of a future happier existence has not hitherto succeeded in dispersing.

E. A. Schäfer

INTERNATIONAL CONGRESS OF MATHEMATICIANS

The fifth International Congress of Mathematicians met at the University of Cambridge from August 21 to 28. The first congress was organized in 1897 at Zürich, the second in Paris in 1900, the year of the exhibition, and meetings have been held at Heidelberg in 1904 and Rome in 1908.

The preparations for the Cambridge congress have been in the hands of a committee with Sir George Darwin as chairman, Sir Joseph Larmor as treasurer and Professors E. W. Hobson, of Cambridge, and A. E. H. Love, of Oxford, as secretaries; and arrangements have been made, with the assistance of the university and colleges of Cambridge, for the entertainment of foreign mathematicians, who were expected to exceed 300. According to advance announcements there were to be four sections concerned with analysis, geometry, applied mathematics, and philosophical, historical and educational questions. Each section meets on the mornings of four days for the consideration and discussion of special topics. In the afternoons provision is made for lectures, of which there are eight. Four of them will be on subjects of pure mathematics, to be given by Professor Bôcher, of Harvard; Professor Borel, of Paris; Professor Enriques, of Bologna, and Professor Landau, of Göttingen. The remaining four lectures are to be delivered by Professor E. W. Brown, of Yale University, on researches on periodicity in the solar system; by Prince Boris Galitzin, of St. Petersburg, on apparatus for recording and investigating earthquakes; by Sir Joseph Larmor, of Cambridge, on the dynamics of radiation, and by Sir William White, on the relations of mathematics to engineering practise.

Among Americans who expected to be present are Professors Bôcher, E. W. Brown, Fine, Huntington, Kasner, Moore, Peirce, Webster.

THE EIGHTH INTERNATIONAL CONGRESS OF APPLIED CHEMISTRY

The eighth International Congress of Applied Chemistry held its inaugural meeting at Washington on September 4, presided over by the president of the United States, and begins its scientific and business meetings in New York on September 6, continuing till September 13. Dr. Edward W. Morley is the honorary president of the congress and Dr. William H. Nichols is the president. An elaborate program has been arranged for the scientific and business meetings, and for the entertainment of visitors. It began on August 31, with receptions to the Society of Chemical Industry and the Verein deutsche Chemiker, and these societies held their meetings in New York prior to the departure for Washington by special train on the afternoon of September 3. Members of the congress returned from Washington on Thursday afternoon, and the sectional meetings open at Columbia University on Friday morning and thereafter sectional meetings are held in the morning and the afternoon. In the afternoons there are public lectures at the College of the City of New York by distinguished chemists whose names have already been given in SCIENCE. An extensive series of banquets, receptions, teas and excursions has been arranged, and at the close of the congress excursions have been planned to Chicago and to California.

SCIENTIFIC NOTES AND NEWS

THE following Americans have expressed their intention to be present at the meeting of the British Association, which opens this week at Dundee: Professor R. E. Allardice, Stanford; Professor Frank Allen, Manitoba; Professor Burton-Opitz, Columbia; Professor Irvine Cameron, Toronto; Professor D. H. Campbell, Stanford; Professor Archibald Clark, Manitoba; Dr. G. W. Field, Boston, Mass.; Professor J. C. Fields, Toronto; Miss Alice Fletcher, Cambridge, Mass.; Dr. W. H. Hale, New York; Professor Paul Hanus, Harvard; Professor Ida Hyde, Kansas; Professor A. E. Kennelly, Harvard; Professor A. B. Macallum, Toronto; Professor J. J. R. Macleod, Western Reserve; Professor J. C. McLennan, Toronto; Professor F. P. Mall, Johns Hopkins; Professor Gustav Mann, Tulane; Dr. S. J. Meltzer, Rockefeller Institute; Professor R. A. Millikan, Chicago; Professor E. C. Moore, Yale; Professor B. O. Peirce, Harvard; Professor F. H. Pike, Columbia; Dr. J. W. Spencer, Washington; Professor Swale Vincent, Manitoba, and Professor A. G. Webster, Clark.

PROFESSOR BERNSTEIN, formerly director of the Laboratory of Physiology at Halle, celebrated on August 3 the fiftieth anniversary of his doctorate.

DR. GUSTAV FRITSCH, honorary professor at Berlin, known for his work on localization in the brain and for his other contributions to physiology, histology and anthropology, has also celebrated the same anniversary.

THE city of Paris has named the pavilion at the St. Anne Asylum in honor of Dr. Valentin Magnan, who has retired from the directorship, which he has held since 1857.

THE King and Queen of Norway on August 20 gave a dinner in honor of Captain Amundsen. He presented the king with the silk flag which he had with him at the South Pole.

MR. A. CROMPTON, a research assistant at the Pasteur Institute, Paris, has been appointed a member of the staff of the Imperial Cancer Research Fund, London.

DR. GEO. R. LYMAN, assistant professor of botany in Dartmouth College, will take the work of Professor Roland Thaxter during the coming year, at Harvard University, while Professor Thaxter is absent on his sabbatical leave.

WE learn from the *Journal* of the American Medical Association that the Southern Medical Association has appointed a special commission consisting of Captain Charles F. Craig, M. C., U. S. Army, chairman; Dr. Graham E. Henson, Crescent City, Fla., secretary, and Drs. R. H. von Ezdorf, U. S. P. H. Service, Mobile; William Kraus, Memphis, Tenn.; Creighton Wellman, New Orleans; William H. Deaderick, Marianna, Ark.; W. S. Thayer, Baltimore, Seale Harris, Mobile, and C. C. Bass, New Orleans. The commission will tabulate information from the entire south on malaria and diseases simulating malaria and will decide on what means will be used for the elimination of this condition.

MR. G. L. CARVER, professor of biology at Mercer University, Macon, Georgia, will spend the coming year in research work at Columbia University. Mr. R. A. Ganz, B.A. (Michigan), will be acting professor of biology at Mercer University.

PROFESSOR HERSCHEL PARKER and Mr. Belmore Brown have returued to Tacoma after reaching a point within three hundred feet from the summit of Mt. McKinley.

PROFESSOR H. VON BUTTEL-REEFEN has returned from an expedition to the East Indies, undertaken under the auspices of the Prussian Academy of Sciences.

DR. C. E. KENNETH MEES on August 20 delivered a lecture before the Illuminating Engineering Society of England on producing in artificial light the exact qualities of daylight.

The Inter-polar Commission will meet at Rome during the meeting of the tenth International Geographical Congress, on April 2, 1913.

The sixth Congress of the International Association for Testing Materials is meeting this week in the Engineering Societies Building, New York City.

UNIVERSITY AND EDUCATIONAL NEWS

A bequest of $100,000 to the University of Manchester, made by Mr. J. E. Taylor, has become payable by the death of his widow.

Dr. Alan W. C. Menzies, assistant professor of chemistry in the University of Chicago, has been appointed head of the department of chemistry at Oberlin College.

On the recommendation of Dr. David Kinley, dean of the Graduate School, the trustees of the University of Illinois authorized a post-doctorate fellowship for study abroad and Miss Margaret L. Bailey has been awarded the fellowship.

Mr. F. J. Lewis, demonstrator in botany in the University of Liverpool, has been appointed professor of biology in the University of Alberta.

Professor W. M. Bayliss, F.R.S., has been appointed professor of general physiology in University College, London.

DISCUSSION AND CORRESPONDENCE

THE CORROSION OF IRON AND STEEL

To the Editor of Science: In a communication from Dr. Allerton S. Cushman, published in Science for August 16, 1912, a certain paragraph in a review of Friend's "Corrosion of Iron and Steel," written by myself last spring, is severely criticized. Dr. Cushman states that this paragraph is,

> based upon an analysis of a single market sample which was manufactured in the early days of a new industry.

And also that I should not

> have included a paragraph in a scientific review, written in such a manner that it could be reprinted and used in a commercial contest with the object of producing a false impression.

Dr. Cushman concludes his two-page communication with a paragraph commencing,

> It would appear to the writer [Dr. Cushman] that there is such a thing as professional ethics in respect to the scientific treatment of scientific books reviewed in a scientific journal, and that such reviews should not be used to introduce false impressions to be afterwards touted about the country as "salesmen's arguments."

Dr. Cushman is surely correct in his assumption that there is such a thing as professional ethics in respect to the scientific treatment of scientific books, but why should he limit such ethics to a review in a scientific journal? Why not extend such ethics to the treatment of scientific books in advertising literature where such scientific books are so quoted as "to introduce false impressions to be afterwards touted about the country as 'salesmen's arguments.'"

The paragraph in the review so strenuously objected to was written not to spread a false impression, but to correct one; not in disregard of professional ethics, but as a consequence of following professional ethics. The review was written for the readers of Science, at the request of its editor, and if it has been reprinted in whole or in part for any purpose whatever I have been and am in entire ignorance of such fact.

The paragraph which is objected to is as follows:

> It is a matter of regret that the author has been misled, as have also the reviewer and others, by giving credence to statements and data supplied by the American Rolling Mill Co., of Middletown, Ohio, which he publishes on pages 114, 250, 276 and 351, regarding the purity of this firm's product. For example, the material said to have the analysis published on page 114, as containing 99.954 per cent. iron, and which on page 276 is proposed as a standard for pure iron on which to base a corrosion factor, was later found by the author himself, much to his surprise, to contain .172 per cent. copper.

The "author" here referred to is of course Dr. Friend, and the analysis is one supplied him by the American Rolling Mill Co. Now Dr. Cushman contends that this analysis, and hence the opinions based upon it, is untrustworthy because it represents but a single sample; because the sample was of early manufacture; because it does not represent the present product of the American Rolling Mill Co. He does not object to the analysis because it is wrong. And yet the firm in whose defence Dr. Cushman so valiantly struggles quotes on pages 8 and 9 of its booklet "Public Opinion on American Ingot Iron," copyrighted in 1912, and distributed to the public as late as last July, these very pages, 114 and 115, of Dr. Friend's book, on which are given in full this analysis and opinions based upon it. If it is ethical for Dr. Cushman or the American Rolling Mill Co. to take advantage of an error (for which it is responsible) in a scientific book, and to print this as advertising matter and to place before the public what is not true, it surely is not a breach of ethics for me to print in a scientific journal a correction of this error and to state what is true.

Why limit professional ethics to scientific book reviews?

WILLIAM H. WALKER

THE INHERITANCE OF ACQUIRED PIGMENTATION

THE brief article on "The Inheritance of Skin Color" in SCIENCE for August 2, by Dr. H. E. Jordan, of the University of Virginia, contains among other matters the following speculation:

> The fact of the apparent histologic identity between brunette and mulatto skins; and the further fact that under protracted exposure to extremes of heat and sun the number of pigment granules is increased in white skin, indicates that pigmentation (dark skin) as evidenced in the negro is an instance of the inheritance of an acquired character. The least that makes a negro a negro is his dark skin. Life-guards in September are frequently almost as black. A negro is specifically such for mental perhaps more than for physical characteristics. . . .

Dr. Jordan certainly fares far afield in offering two opinions—(1) the transmission of an acquired character, (2) that a negro is a negro more for his mental than his physical characters, against all of the verifiable facts and experiments now available.

Although the peculiar fact of negro pigmentation and its origin can not be experimentally tested, the experiment of increasing and decreasing pigmentation by segregation is open to all of us. The work so voluminously before us on rats, mice, guinea-pigs, cattle, poultry and other animals are one hundred per cent. against Dr. Jordan's unfounded speculation of pigmentation (in the negro or in a blue mouse) as an instance of the acquired character afterwards inherited. Segregation in the dark African jungles has all the experimental proof in its favor.

That the negro is specifically a negro "for mental perhaps more than for physical characteristics" is another opinion not supported by the verifiable facts. The kinky hair, thick lips, pigmentation, extensive genitalia and prepuce, nasal formation, weight of skull, length and thickness of bones, and the other physical peculiarities of the African are, to put it mildly, as much the biometrician's, the anthropologist's as the layman's method of diagnosing the negro from another race. I should like to learn of the mental differences.

It seems to me unnecessary to discuss Dr. Jordan's opinion that the Italians, Spanish and Anglo-Saxon brunettes "may owe their pigmentation to negroid ancestry."

LEONARD KEENE HIRSHBERG
JOHNS HOPKINS UNIVERSITY

SCIENTIFIC BOOKS

Theoretische Astronomie. Von W. KLINKERFUES. Dritte verbesserte und vermehrte Ausgabe, bearbeitet von Professor Dr. H. BUCHHOLZ. XXXVIII., 1067 u. 12 S. 4°. Mit 67 Abbild. In stark. Leinenband 50 M. Verlag von Friedr. Vieweg & Sohn in Braunschweig.

The first edition of Klinkerfues's "Theoretische Astronomie" appeared in the year 1870, shortly after the publication of the classical treatises of Watson and Oppolzer, and in the intervening years has been an indispensable source of information to those interested in the computational field of astronomy.

A second edition, rewritten and enlarged under the editorship of Professor Buchholz, appeared in 1899; and the third edition, edited again by Professor Buchholz, has grown by the addition of one hundred and fifty pages to such large proportions that the volume is both bulky and heavy. An eleven-hundred-page book can not be handled conveniently, and a continued use of the book will put its binding to a severe test. The press-work is all that could be desired and the diagrams are excellent.

The computational field of astronomy—perhaps we might say the book-keeping, or auditing department—has for some peculiar reason appropriated the title of "theoretical astronomy." It is not peculiarly theoretical; rather it is the link which binds together the worker in celestial mechanics and the observing astronomer. To the observing astronomer it brings the results of theory; and as the observing astronomers are the "practical" astronomers, and are the more numerous, perhaps this misnomer can be charged to them. At any rate, a science so old and so exact as astronomy should be a little more careful with its titles. The "practical" astronomers are no more practical than other astronomers, and the computing astronomer has no monopoly of the theoretical aspect of the subject. And so we warn the uninitiated not to anticipate in this book an account of that delightful body of theory which constitutes the science of astronomy. It is, on the contrary, an exhaustive treatise by an auditor explaining in detail the best methods of making up the astronomical accounts.

The subject matter of the volume is divided into nine parts and subdivided into one hundred and thirty-three "Vorlesungen." The topics treated are: I., Calculation of the Position of a Celestial Object from its Orbital Elements; II., Calculation of an Orbit from Given Observations; III., Determination of the Parabolic Orbits of Comets; IV., Determination of Elliptic Orbits; V., Determination of Elliptic Orbits from Four Observations, Only Three of Which are Complete; VI., On Mechanical Quadrature and the Methods of Special Perturbations; VII., Calculation of an Orbit from Many Observations According to the Methods of Least Squares; VIII., Calculation of Double Star Orbits; IX., On the Determination of the Orbits of Meteors; Supplement I., Tables; Supplement II., Leuchner's Method of Computing Orbits.

The principal additions which have been made since the second edition are contained in Part IV., in the tables, and in Supplement II., all of which relate to Leuschner's method of computing orbits. Of the three essentially distinct methods of computing orbits, viz., the methods of Gauss, Laplace and Gibbs, the one of Gauss, with various modifications, has been the one generally employed. The method of Laplace contained computational difficulties which have precluded its use.

Recognizing the theoretical advantages of Laplace's method, and also its computational disadvantages, Professor A. O. Leuschner, of the University of California, has given a great deal of study to its improvement. As a result of his work he has evolved a method which he has designated "The Short Method" (an unfortunate title for various reasons). Leuschner's method, with the aid of the tables he has constructed for it, is decidedly practical, and we are glad to see an adequate account of it given in this new edition of Klinkerfues's "Theoretische Astronomie."

We look in vain, however, for a valuable improvement to Gauss's method given in 1901 by Professor F. R. Moulton, of the University of Chicago.[1] After the heliocentric distances have been determined there are difficulties, both theoretical and practical, according to Gauss, in the determination of the elements a, e, ω. Not only is the method of Professor Moulton theoretically more direct than that of Gauss but it is computationally much more simple; moreover, it makes no assumption as to the species of the conic.

In the way of a minor error we notice that the formula for parabolic orbits,

[1] *Astronomical Journal*, No. 510.

$$(r_1 + r_2 + s)^{3/2} \mp (r_1 + r_2 - s)^{3/2} = 6\kappa(t_2 - t_1),$$

is ascribed to Lambert. Long ago, Tisserand called attention in his "Mécanique Céleste" to the fact that this formula was first given by Euler. To Lambert is due the corresponding formula for elliptic orbits.

In so large a volume, containing so much standard material, it is impossible to enter much into details. Nearly all the methods described are abundantly illustrated with numerical examples. As the text itself is clear and the author's style nearly always good, there would seem to be no reason why any one with the proper mathematical equipment should experience any difficulty in understanding it, which can not be said of either Watson or Oppolzer. Without doubt, it is the most valuable work on "Computational Astronomy" which we have.

W. D. MACMILLAN

Modern Microscopy. A Handbook for Beginners and Students. By M. I. CROSS and MARTIN J. COLE, Lecturer in Histology in Cook's School of Anatomy. Fourth edition, revised and enlarged, with chapters on special subjects by various writers. Chicago, Chicago Medical Book Co. 1912.

Time was when "microscopy" had a distinct place in the range of the sciences. This was, however, before the day when the microscope had become an instrument so subordinated to the scientific branches in which it is largely used. That time was marked by a lively curiosity in the world of the very small which expressed itself in the establishment of microscopical clubs, societies, journals, etc.

Popular interest in the "microscope and its revelations" seems to have been largely lost at the present day, perhaps as the detailed results of its use have become more public property. This change of attitude which seems to the reviewer a real one is for many reasons to be deplored, so that such a book as the one whose title is given above should have a distinct place as a guide book for amateur microscopists—but only as such. Attempting to cover, as it does, practically the entire field in which the microscope is applied, it necessarily falls short as a book for professional workers or serious students in the various fields.

The book is clearly written, fairly illustrated with a selection of figures, in general well chosen. The formulas of preserving fluids, stains and similar prescriptions are standard, although the selection often does not reveal a thorough familiarity with the more recent advances in the field.

Five chapters constitute Part I. on the Microscope and its Accessories. Part II., fifteen chapters, is devoted to the technique of animal and vegetable examination by means of the microscope, together with chapters on mounting entomological specimens, crystals, diatomes, etc. Part III. comprises special chapters by special writers on The Petrological Microscope, Rotifers, Mites, Foraminifera, Mosses and Liverworts, The Microscope and Nature Study and the Microscopy of Foods.

The book is therefore believed to have its place as a means of arousing and encouraging the interest of the layman in the world around him.

As a book for use in America, by Americans, however, it is believed that it would meet the demands that will be made of it better if it were to take some recognition of the excellent microscopes put out by such firms as The Bausch & Lomb Optical Company and the Spencer Lens Company among others. The special chapters, furthermore, deal with a peculiarly English fauna.

B. F. KINGSBURY

NUMBER OF SPECIES OF LIVING VERTEBRATES

RECENTLY I have had occasion to make an estimate of the number of known species of living vertebrates. After consultation with a number of specialists, the figures below have been fixed on as a reasonably close approximation to the truth. Thinking these estimates may be of interest to others, I send them to SCIENCE to publish for what they are worth. Such figures can not, of course, be accurate if for no other reasons than that in compiling them no attempt has been made to discriminate between forms described as species or as subspecies or varieties, or to determine how many of the named and recorded species will ultimately have to be relegated to the scrap heap and be listed only as synonyms. Still less is the rôle of prophet assumed and an attempt made to go beyond present returns and indicate how many vertebrate species yet remain to be described, although it is believed that in the case of some orders (as, for instance, birds and mammals) reasonably good guesses might be made. The estimate is as follows:

1. Mammals	7,000
2. Birds	20,000
3. Crocodiles and turtles	300
4. Lizards	3,300
5. Snakes	2,400
6. Frogs and toads	2,000
7. Salamanders	200
8. Fishes	12,000
Total	47,200

H. W. Henshaw

Washington, D. C.,
August 5, 1912

SPECIAL ARTICLES

ON THE SIGNIFICANCE OF VARIETY TESTS

In the United States, considerable money and effort have been devoted to "variety tests." This has been done upon the assumption that the relative yield of a given variety in one year is a reasonably good criterion of its relative value in a subsequent year. But to some of us, the value of variety tests as they have been carried out by many of our state agricultural experiment stations seems very doubtful.[1]

The utility of a test of n varieties is measured by the correlation between the yields of the individual varieties for different years. If the correlation be 0, the yield of a variety in 1912 furnishes no criterion of its probable productiveness as compared with others in 1913. If the correlation be high, then the prediction of yield from one year's test may be made with great certainty.

Let us apply this test to a series of data given by Hall[2] for eleven years' test of a number of varieties of wheat at Rothamsted. I presume we can look upon these tests as not only more extensive but more trustworthy than many or most of those in experiment station records.

We may assume that, aside from the errors of sampling, two kinds of influences determine observed yield: the innate capacity of the variety and the conditions of growth to which it is exposed—that is, the influences attaching to soil and season. We may correct, in part at least, for the influence of season by determining the mean yield of all the varieties for each year to the nearest tenth bushel and expressing the yield of each variety for that year as a deviation from the general yearly mean. These deviations with their signs show in concrete terms the relative superiority or inferiority of a variety for a given year. Its value agriculturally, of course, depends upon the consistency with which it maintains its superiority from year to year.

Table I. has been prepared from Professor Hall's (which is arranged according to the superiority of varieties as judged at Rotham-

[1] There are several difficulties which have been but poorly met in the problem of variety testing. The identity of the variety must be beyond question, but in many cases there may be grave doubts as to the authenticity of the identifications, and in the absence of herbarium records, it is impossible to correct errors. The organization of scientifically managed seed growers' associations may be expected to overcome this difficulty in large part. Again, varieties differ in their edaphic and climatic requirements. Tests made in one place may give results not at all applicable to other localities with different conditions. Where the tests are made by wide cooperative experiments, this difficulty may be overcome, but when work is confined to a central station its value for a diversified state is *a priori* doubtful. Third, any test is subject to the probable errors of random sampling, and for the most part we have been given no means of estimating the magnitude of this measure of possible untrustworthiness. If the empirical measure of the desirability of a given variety is misleading in a particular year, it is of little value for predicting the probable yield of the variety in a subsequent year!

[2] Hall, A. D., "The Book of the Rothamsted Experiments," p. 66, 1905.

TABLE I

Deviation of Yields of Varieties from the Yearly Means

	1871	1872	1873	1874	1875	1876	1877	1878	1879	1880	1881	Lots
Rivet (Red)	——	——	+ 9.3	+16.3	+11.6	——	+ 6.7	+14.3	− 4.5	− 1.7	+ 5.7	9
White Chaff (Red)	——	——	+ 1.8	+ 4.4	+ 3.4	+ 7.0	+ 5.5	+ 7.2	+ 2.3	+ 4.0	+ 8.0	9
Club Wheat (Red)	+ 3.8	+ 3.5	+ 8.7	+ 8.9	+ 9.8	+ 5.1	+ 6.6	+ 9.2	+ 3.0	− 7.7	− 3.1	11
Golden Drop (Red) Hallett's	+ 7.3	+ 7.5	+ 5.4	+ 1.1	+ 1.3	+ 5.9	+ 6.6	+ 1.0	+ .5	− 5.2	+ 4.3	11
Bole's Prolific (Red)	+ 1.4	+ .5	+ 6.4	− 2.6	+ 7.5	− 1.1	+ 1.9	+ 1.0	+10.5	+ .4	——	11
Hardcastle (White)	——	+ 4.2	+ 3.2	− 1.1	− 2.9	+ 1.5	− .8	+ 2.2	+ 1.0	+ .3	− .9	10
Red Rostock	+ 4.8	——	+ 7.5	+ 3.1	+ .6	− 2.5	+ 3.5	+ 5.2	−12.0	+ 4.3	− .7	10
Red Langham	− 1.4	+ 1.5	− 4.7	+ 2.4	− 1.9	——	——	− 1.0	+ 5.3	+ 4.5	+ 2.0	11
Bristol Red	− 2.8	+ 2.1	+ .7	+ 2.7	− 5.2	− .1	+ 1.2	+ .3	+ 1.1	+ 6.5	− .3	11
Red Wonder	− 1.0	+ 1.5	− 1.7	+ 4.4	− 3.6	+ 1.7	− 1.3	+ .3	+ 1.5	+ 4.1	− .6	11
Red Chaff (White)	+ .6	− 5.3	− 3.5	− 1.9	− 2.5	+ 1.3	− 1.9	——	——	——	——	7
Browick (Red)	+ 3.1	− 1.8	− .3	+ .4	+ 1.7	− 3.4	− 2.0	− 2.3	+ 3.5	− 4.5	+ .8	11
Casey's White	− 2.3	− .2	− 1.3	+ 1.4	+ 2.2	+ 3.0	+ .1	− 4.0	− 5.1	——	− 3.6	11
Red Nursery	+ 1.9	+ 3.0	−11.7	− 9.6	+ 2.2	− 5.0	− 2.3	− 4.0	+10.4	+ 3.4	− .5	11
Wooly Ear (White)	− 1.0	+ .5	− 1.8	+ .6	− .7	+ 4.1	− 5.3	− 3.5	− .5	− 3.1	− 2.4	11
Burwell (Old Red Lammas)	− 1.1	− 1.0	− 3.7	− 3.4	+ 1.7	− 4.1	− 3.9	− 5.5	+ 6.5	+ 2.9	− 1.7	11
Golden Rough Chaff (Red)	+ .8	− 3.0	− .3	+ 1.4	+ 2.0	− 4.1	− 6.5	− 5.0	− 6.1	+ 7.2	− 4.9	11
Chubb Wheat (Red)	− 3.8	− 2.3	− 3.0	− .2	+ 1.5	− 2.2	− 1.4	+ 3.3	+ .3	− 9.2	——	10
Original Red (Hallett's)	− 2.2	− 7.0	− 2.4	− 7.1	−10.8	− 2.4	+ 1.5	——	——	——	——	7
Victoria White (Hallett's)	+ 1.6	+ 3.0	− .5	− 6.4	− 3.0	− 1.4	− .3	− 7.9	− 5.6	− 8.3	− 2.5	11
White Chiddam	− 5.3	− 3.5	− 7.0	− 8.7	− 4.4	− 5.0	− 5.3	− 2.0	− 8.6	+ 3.3	+ .6	11
Hunter's White (Hallett's)	− 5.3	− 2.5	− .8	− 5.3	−10.4	+ 1.0	− 2.9	− 9.5	− 3.1	− 1.3	——	10
Number of Lots	19	19	22	22	22	22	22	20	20	20	18	226
Averages	32.2	42.3	38.8	50.7	36.8	42.5	42.9	51.8	20.5	24.1	46.5	

sted) in this manner. We note that the deviations in the upper portion of the table are generally positive, while those in the lower half are generally negative. There are, however exceptions even in sign and the magnitude of the deviations varies greatly.

How low the prediction value of a single yield is may be seen at once by correlating between the relative yield of the same variety in different years. Symmetrical intra-class tables[3] or condensed tables may be formed or the coefficient may be calculated from the moments of the deviations of the individual varieties by a convenient formula to be published shortly. We find

$$r = .266.$$

It is most instructive to compare the correlations between the relative yield of the different varieties in the same year. This furnishes a measure of the influence of season. Table II. shows the deviations of the yields for each year from the mean yield of the variety for all the years it has been grown. That season has an immensely greater influence than variety in determining yield is obvious at once from a comparison of Table II. with Table I. The coefficient of correlation between the deviations of the different varieties from their means in the same year is

$$r = .837.$$

It is evident that with such a relatively low value of the correlation between the yield of varieties in different seasons, little importance can be attached to such "variety tests" as have been generally carried out in Agricultural Experiment Stations. Yet in the future development of breeding, variety testing must hold a most important place in station work, for obviously it is idle to breed new varieties unless they can be certainly demonstrated to be superior to those already existing.

[3] *Amer. Nat.*, Vol. 45, pp. 566–571, 1911; also a second paper, *Amer. Nat.*, in press.

TABLE II

Deviations of the Yield of the Varieties from their own Means in Different Years

	1871	1872	1873	1874	1875	1876	1877	1878	1879	1880	1881	Averages
Rivet (Red)..........	——	——	+ 2.3	+21.2	+ 2.6	− 3.3	+ 3.8	+20.3	−29.8	−23.4	+ 6.4	45.8
White Chaff (Red)....	——	——	− 3.6	+12.8	− 4.0	+ 5.3	+ 4.2	+14.8	−21.4	−16.1	+10.3	44.2
Club Wheat (Red)	− 7.4	+ 2.4	+ 4.0	+ 4.2	+16.2	+ 3.2	+ 6.1	+17.6	−19.9	−27.0	——	43.4
Golden Drop (Red) Hallett's...........	− 2.8	+ 7.5	+ 1.9	+ 9.5	− 4.2	+ 6.1	+ 7.2	+10.5	−21.3	−23.4	+ 8.5	42.3
Bole's Prolific (Red)...	− 7.7	+ 1.5	+ 3.9	+ 6.8	+ 2.5	+ .1	+ 3.5	+11.5	−10.3	−16.8	+ 5.2	41.3
Hardcastle (White)....	——	+ 6.1	+ 1.6	+ 9.2	− 6.5	+ 3.6	+ 1.7	+13.6	−18.9	−16.0	+ 5.2	40.4
Red Rostock.........	− 3.1	——	+ 6.2	+13.7	− 2.7	− .1	+ 6.3	+16.9	−31.6	−11.7	+ 5.7	40.1
Red Langham........	− 8.8	+ 4.2	− 5.5	+13.5	− 4.7	+ 2.9	+ 3.3	+11.2	−13.8	−11.0	+ 8.9	39.6
Bristol Red..........	−10.2	+ 4.8	− .1	+13.8	− 8.0	+ 2.8	+ 4.5	+12.5	−18.0	− 9.0	+ 6.6	39.6
Red Wonder.........	− 8.3	+ 4.3	− 2.4	+15.6	− 6.3	+ 4.7	+ 2.1	+12.6	−17.5	−11.3	+ 6.4	39.5
Red Chaff (White)....	− 6.2	− 2.0	− 3.7	+ 9.8	− 4.7	+ 4.8	+ 2.0					39.0
Browick (Red)........	− 3.3	+ 1.9	− .1	+12.5	− .1	+ .5	+ 2.3	+10.9	−14.6	−19.0	+ 8.7	38.6
Casey's White........	− 8.2	+ 4.0	− .6	+14.0	+ .9	+ 7.4	+ 4.9	+ 9.7	−22.7	−14.0	+ 4.8	38.1
Red Nursery.........	− 3.8	+ 7.4	−10.8	+ 3.2	+ 1.1	− .4	+ 2.7	+ 9.9	− 7.0	−10.4	+ 8.1	37.9
Wooly Ear (White) ...	− 6.6	+ 5.0	− .8	+13.5	− 1.7	+ 8.8	− .3	+10.5	−17.8	−16.8	+ 6.3	37.8
Burwell (Old Red Lammas)..........	− 6.7	+ 3.5	− 2.7	+ 9.5	+ .7	+ .6	+ .6	+ 8.5	−10.8	−10.8	+ 7.0	37.8
Golden Rough Chaff (Red).............	− 4.3	+ 2.0	+ 1.2	+14.8	+ 1.5	+ 1.1	− .9	+ 9.5	−22.9	− 6.0	+ 4.3	37.3
Chubb Wheat (Red) ..	− 8.2	+ 3.4	− .8	+13.9	+ 1.7	+ 3.7	+ 4.9	+18.5	−15.8	−21.7	——	36.6
Original Red (Hallett's)	− 6.5	− 1.2	− .1	+ 7.1	−10.5	+ 3.6	+ 7.9	——	——	——	——	36.5
Victoria White (Hallett's).........	− 2.4	+ 9.1	+ 2.1	+ 8.1	− 2.4	+ 4.9	+ 6.4	+ 7.7	−21.3	−20.4	+ 7.8	36.2
White Chiddam.......	− 7.9	+ 4.0	− 3.0	+ 7.2	− 2.4	+ 2.7	+ 2.8	+15.0	−22.9	− 7.4	+12.3	34.8
Hunter's White (Hallett's).........	− 7.4	+ 5.5	+ 3.7	+11.1	− 7.9	+ 9.2	+ 5.7	+ 8.0	−16.9	−11.5	——	34.3
Number of Lots	19	19	22	22	22	22	22	20	20	20	18	

Is it not time for a concerted and systematic effort on the part of those interested in agricultural science to put this important problem on a sound basis, biologically and statistically?

J. Arthur Harris

Cold Spring Harbor, L. I.,
July 17, 1912

THE VISCOSITY OF GASES AND THE BUNSEN FLAME

In the long experience with the Bunsen flame, which I had some years ago, when these flames were still the only available approach to high temperatures on a large scale, it always struck me as curious that a flame which was quite colorless when the burner was cold should turn whitish when coming from a hot burner. The effect is marked when the combustion gases issue from a long narrow slit, cut from end to end of a horizontal tube 4 inches long. When the cap is removed from the remote end of such a tube, the flame will sputter, showing large excess of air; on closing the tube, it is long narrow pure blue line, burning quietly. When the tube gets hot the flame shows an internal white margin, which again vanishes when the tube is cooled, by water, for instance.

It is clear that for the hot tube there is a deficiency of air, in spite of the excessive room for ingress of air below. Since the gas supplied to the jet remains constant, the intake of air depends upon the rapidity of the escape of gases at the flame. The more rapid the escape, the greater the admixture for the same quantity of gas, and the nearer the flame approached to that of a blast lamp. Hence when the tube at the slot is heated, the escape of gas is retarded owing to the increased viscosity of air at high temperatures. Relatively little air is taken in because the escape of combustion gases is relatively small. This simple experiment, therefore, has a direct and interesting bearing on the viscosity of gases.

C. Barus

Brown University

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THE NATURE OF HEAT[1]

I propose to consider on the present occasion some of our fundamental ideas with regard to the nature of heat, and in particular to suggest that we might with advantage import into our modern theory some of the ideas of the old caloric or material theory which has for so long a time been forgotten and discredited. In so doing I may appear to many of you to be taking a retrograde step, because the caloric theory is generally represented as being fundamentally opposed to the kinetic theory and to the law of the conservation of energy. I would, therefore, remark at the outset that this is not necessarily the case, provided that the theory is rightly interpreted and applied in accordance with experiment. Mistakes have been made on both theories, but the method commonly adopted of selecting all the mistakes made in the application of the caloric theory and contrasting them with the correct deductions from the kinetic theory has created an erroneous impression that there is something fundamentally wrong about the caloric theory, and that it is in the nature of things incapable of correctly representing the facts. I shall endeavor to show that this fictitious antagonism between the two theories is without real foundation. They should rather be regarded as different ways of describing the same phenomena. Neither is complete without the other. The kinetic theory is generally preferable for elementary exposition, and has come to

[1] Address of the president to the Mathematical and Physical Science Section of the British Association for the Advancement of Science. Dundee, 1912. The introductory remarks have been omitted.

be almost exclusively adopted for this purpose; but in many cases the caloric theory would have the advantage of emphasizing at the outset the importance of fundamental facts which are too often obscured in the prevailing method of treatment.

The explanation of the development of heat by friction was one of the earliest difficulties encountered by the caloric theory. One explanation, maintained by Cavendish and others, was simply that caloric was generated *de novo* by friction in much the same way as electricity. Another explanation, more commonly adopted, was that the fragments of solid, abraded in such operations as boring cannon, had a smaller capacity for heat than the original material. Caloric already existing in the substance was regarded as being squeezed or ground out of it without any fresh caloric being actually generated. The probability of the second explanation was negatived by the celebrated experiments of Rumford and Davy; who concluded that friction did not diminish the capacities of bodies for heat, and that it could not be a material substance because the supply obtainable by friction appeared to be inexhaustible. Rumford also showed that no increase of weight in a body when heated could be detected by the most delicate apparatus available in his time. Caloric evidently did not possess to any marked extent the properties of an ordinary ponderable fluid; but, if it had any real existence and was not merely a convenient mathematical fiction, it must be something of the same nature as the electric fluids, which had already played so useful a part in the description of phenomena, although their actual existence as physical entities had not then been demonstrated. Heat, as Rumford and Davy maintained, might be merely a mode of motion or a vibration of the ultimate particles of matter, but the idea in this form was too vague to serve as a basis of measurement or calculation. The simple conception of caloric, as a measurable quantity of something, sufficed for many purposes, and led in the hands of Laplace and others to correct results for the ratio of the specific heats, the adiabatic equation of gases, and other fundamental points of theory, though many problems in the relations of heat and work remained obscure.

The greatest contribution of the caloric theory to thermodynamics was the production of Carnot's immortal "Reflections on the Motive Power of Heat." It is one of the most remarkable illustrations of the undeserved discredit into which the caloric theory has fallen, that this work, the very foundation of modern thermodynamics, should still be misrepresented, and its logic assailed, on the ground that much of the reasoning is expressed in the language of the caloric theory. In justice to Carnot, even at the risk of wearying you with an oft-told tale, I can not refrain from taking this opportunity of reviewing the essential points of his reasoning, because it affords incidentally the best introduction to the conception of caloric, and explains how a quantity of caloric is to be measured.

At the time when Carnot wrote, the industrial importance of the steam engine was already established, and the economy gained by expansive working was generally appreciated. The air-engine, and a primitive form of the internal-combustion engine, had recently been invented. On account of the high value of the latent heat of steam, it was confidently expected that more work might be obtained from a given quantity of heat or fuel by employing some other working substance, such as alcohol or ether, in place of steam. Carnot set himself to investigate the conditions under which motive-power was obtainable from heat, how the efficiency was limited, and whether other agents were preferable to steam. These were questions of immediate practical importance to the engineer, but the answer which Carnot found embraces the whole range of science in its ever widening scope.

In discussing the production of work from heat it is necessary, as Carnot points out, to consider a complete series or cycle of operations in which the working substance, and all parts of the engine are restored on completion of the cycle to their initial state. Nothing but heat, or its equivalent fuel, may be supplied to the engine. Otherwise part of the motive power obtained might be due, not to heat alone, but to some change in the working substance, or in the disposition of the mechanism. Carnot here assumes the fundamental axiom of the cycle, which he states as follows: "*When a body has undergone any changes, and, after a certain number of transformations, is brought back identically to its original state, considered relatively to density, temperature, and mode of aggregation, it must contain the same quantity of heat as it contained originally.*" This does not limit the practical application of the theory, because all machines repeat a regular series of operations, which may be reduced in theory to an equivalent cycle in which everything is restored to its initial state.

The most essential feature of the working of all heat-engines, considered apart from details of mechanism, is the production of motive power by alternate expansion or contraction, or heating and cooling of the working substance. This necessitates the existence of a difference of temperature, produced by combustion or otherwise, between two bodies, such as the boiler and condenser of a steam engine, which may be regarded as the source and sink of heat respectively. Wherever a difference of temperature exists, it may be made a source of motive power, and conversely without difference of temperature, no motive power can be obtained from heat by a cyclical or continuous process. From this consideration Carnot deduces the simple and sufficient rule for obtaining the maximum effect: "*In order to realize the maximum effect, it is necessary that, in the process employed, there should not be any direct interchange of heat between bodies at sensibly different temperatures.*" Direct transference of heat between bodies at sensibly different temperatures would be equivalent to wasting a difference of temperature which might have been utilized for the production of motive power. Equality of temperature is here assumed as the limiting condition of thermal equilibrium, such that an infinitesimal difference of temperature will suffice to determine the flow of heat in either direction. An engine satisfying Carnot's rule will be reversible so far as the thermal operations are concerned. Carnot makes use of this property of reversibility in deducing his formal proof that an engine of this type possesses the maximum efficiency. If in the usual or direct method of working such an engine takes a quantity of heat Q from the source, rejects heat to the condenser, and gives a balance of useful work W per cycle, when the engine is reversed and supplied with motive power W per cycle it will in the limit take the same quantity of heat from the condenser as it previously rejected, and return to the source the same quantity of heat Q as it took from it when working direct. All such engines must have the same efficiency (measured by the ratio W/Q of the work done to the heat taken from the source) whatever the working substance, provided that they work between the same temperature limits. For, if this were not the case, it would be theoretically possible, by employing the most efficient to drive the least efficient reversible engine backwards, to restore to the source all the heat taken from it, and to obtain a balance of useful work without the consumption of fuel; a result sufficiently improbable to serve as the basis of a formal proof. Carnot thus deduces his famous principle, which he states as follows: "*The motive power obtainable from heat is independent of the agents set at work to realize it. Its quantity is fixed solely by the temperatures between which in the limit the transfer of heat takes place.*"

Objection is commonly taken to Carnot's proof, on the ground that the combination which he imagines might produce a balance of useful work without infringing the principle of conservation of energy, or constituting what we now understand as perpetual motion of the ordinary kind in mechanics. It has become the fashion to introduce the conservation of energy in the course of the proof, and to make a final appeal to some additional axiom. Any proof of this kind must always be to some extent a matter of taste; but since Carnot's principle can not be deduced from the conservation of energy alone, it seems a pity to complicate the proof by appealing to it. For the particular object in view, the absurdity of a heat engine working without fuel appears to afford the most appropriate improbability which could be invoked. The final appeal must be to experiment in any case. At the present time the experimental verification of Carnot's principle in its widest application so far outweighs the validity of any deductive proof, that we might well rest content with the logic that satisfied Carnot instead of confusing the issue by disputing his reasoning.

Carnot himself proceeded to test his principle in every possible way by comparison with experiment as far as the scanty data available in his time would permit. He also made several important deductions from it, which were contrary to received opinion at the time, but have since been accurately verified. He appears to have worked out these results analytically in the first instance, as indicated by his footnotes, and to have translated his equations into words in the text for the benefit of his non-mathematical readers. In consequence of this, some of the most important conclusions appear to have been overlooked or attributed to others. Owing to want of exact knowledge of the properties of substances over extended ranges of temperature, he was unable to apply his principle directly in the general form for any temperature limits. We still labor to a less extent under the same disability at the present day. He showed, however, that a great simplification was effected in its application by considering a cycle of infinitesimal range at any temperature t. In this simple case the principle is equivalent to the assertion that the work obtainable from a unit of heat per degree fall (or per degree range of the cycle) at a temperature t, is some function $F't$ of the temperature (generally known as Carnot's function), which must be the same for all substances at the same temperature. From the rough data then available for the properties of steam, alcohol and air, he was able to calculate the numerical values of this function in kilogrammeters of work per kilocalorie of heat at various temperatures between 0° and 100° C., and to show that it was probably the same for different substances at the same temperature within the limits of experimental error. For the vapor of alcohol at its boiling point, 78°.7 C., he found the value $F't = 1.230$ kilogrammeter per kilocalorie per degree fall. For steam at the same temperature he found nearly the same value, namely, $F't = 1.212$. Thus no advantage in point of efficiency could be gained by employing the vapor of alcohol in place of steam. He was also able to show that the work obtainable from a kilocalorie per degree fall probably diminished with rise of temperature, but his data were not sufficiently exact to indicate the law of the variation.

The equation which Carnot employed in deducing the numerical values of his function from the experimental data for steam and alcohol is simply the direct expression of his principle as applied to a saturated vapor. It is now generally known as Clapeyron's equation, because Carnot did not happen to give the equation itself in algebraic form, although the principle and details of the calculation were most minutely and accurately described. In calculating the value of his function for air, Carnot made use of the known value of the difference of the specific heats at constant pressure and volume. He showed that this difference must be the same for equal volumes of all gases measured under the same temperature and pressure, whereas it had always previously been assumed that the ratio (not the difference) of the specific heats was the same for different gases. He also gave a general expression for the heat absorbed by a gas in expanding at constant temperature, and showed that it must bear a constant ratio to the work of expansion. These results were verified experimentally some years later, in part by Dulong, and more completely by Joule, but Carnot's theoretical prediction has generally been overlooked, although it was of the greatest interest and importance. The reason of this neglect is probably to be found in the fact that Carnot's expressions contained the unknown function $F't$ of the temperature, the form of which could not be deduced without making some assumptions with regard to the nature of heat and the scale on which temperature should be measured.

It was my privilege to discover a few years ago that Carnot himself had actually given the correct solution of this fundamental problem in one of his most important footnotes, where it had lain buried and unnoticed for more than eighty years. He showed by a most direct application of the caloric theory, that if temperature was measured on the scale of a perfect gas (which is now universally adopted) the value of his function $F't$ on the caloric theory would be the same at all temperatures, and might be represented simply by a numerical constant A (our "mechanical equivalent") depending on the units adopted for work and heat. In other words, the work W done by a quantity of caloric Q in a Carnot cycle of range T to T_0 on the gas scale would be represented by the simple equation:

$$W = AQ(T - T_0).$$

It is at once obvious that this solution, obtained by Carnot from the caloric theory, so far from being inconsistent with the mechanical theory of heat, is a direct statement of the law of conservation of energy as applied to the Carnot cycle. If the lower limit T_0 of the cycle is taken at the absolute zero of the gas thermometer, we observe that the maximum quantity of work obtainable from a quantity of caloric Q at a temperature T is simply AQT, which represents the absolute value of the energy carried by the caloric taken from the source at the temperature T. The energy of the caloric rejected at the temperature T_0 is AQT_0. The external work done is equal to the difference between the quantities of heat energy supplied and rejected in the cycle.

The analogy which Carnot himself employed in the interpretation of this equation was the oft-quoted analogy of the waterfall. Caloric might be regarded as possessing motive power or energy in virtue of elevation of temperature just as water may be said to possess motive power in virtue of its head or pressure. The limit of motive power obtainable by a reversible motor in either case would be directly proportional to the head or fall measured on a suitable scale. Caloric itself was not motive power, but must be regarded simply as the vehicle or carrier of energy, the production of motive power from caloric depending essentially (as Carnot puts it) not on the actual consumption of caloric, but on the fall of temperature available. The measure of a quantity of caloric is the work done per degree fall, which corresponds with the measure of a quantity of water by weight, *i. e.*, in kilogrammeters per meter fall.

That Carnot did not pursue the analogy further, and deduce the whole mechanical theory of heat from the caloric theory, is hardly to be wondered at if we remember that no applications of the energy principle had then been made in any department of physics. He appears, indeed, at a later date to have caught a glimpse of the general principle when he states that "motive power [his equivalent for work or energy] changes its form but is never annihilated." It is clear from the posthumous notes of his projected experimental work that he realized how much remained to be done on the experimental side, especially in relation to the generation of caloric by friction, and the waste of motive power by conduction of heat, which appeared to him (in 1824) "almost inexplicable in the present state of the theory of heat."

One of the points which troubled him most in the application of the theoretical result that the work obtainable from a quantity of caloric was simply proportional to the fall of temperature available, was that it required that the specific heat of a perfect gas should be independent of the pressure. This was inconsistent with the general opinion prevalent at the time, and with one solitary experiment by Delaroche and Bérard, which appeared to show that the specific heat of a gas diminished with increase of pressure, and which had been explained by Laplace as a natural consequence of the caloric theory. Carnot showed that this result did not necessarily follow from the caloric theory, but the point was not finally decided in his favor until the experiments of Regnault, first published in 1852, established the correct values of the specific heat of gases, and proved that they were practically independent of the pressure.

Another point which troubled Carnot was that, according to his calculations, the motive power obtainable from a kilocalorie of heat per degree fall appeared to diminish with rise of temperature, instead of remaining constant. This might have been due to experimental errors, since the data were most uncertain. But, if he had lived to carry out his projected experiments on the quantity of motive power required to produce one unit of heat, and had obtained the result, 424 kilogrammeters per kilocalorie, subsequently found by Joule, he could hardly have failed to notice that this was the same (within the limits of experimental error) as the maximum work AQT obtainable from the kilocalorie according to his equation. (This is seen to be the case when the values calculated by Carnot per degree fall at different temperatures were multiplied by the absolute temperature in each case. *E. g.*, 1.212 kilogrammeter per degree fall with steam at 79° C. or 352° Abs. $1.212 \times 352 = 426$ kilogram-meters.) The origin of the apparent discrepancy between theory and experiment lay in the tacit assumption that the quantity of caloric in a kilocalorie was the same at different temperatures. There were no experiments at that time available to demonstrate that the caloric measure of heat as work per degree fall, implied in Carnot's principle, or more explicitly stated in his equation, was not the same as the calorimetric measure obtained by mixing substances at different temperatures. Even when the energy principle was established its exponents failed to perceive exactly where the discrepancy between the two theories lay. In reality both were correct, if fairly interpreted in accordance with experiment, but they depended on different methods of measuring a quantity of heat, which, so far from being inconsistent, were mutually complementary.

The same misconception, in a more subtle and insidious form, is still prevalent in such common phrases as the following: "We now know that heat is a form of energy and not a material fluid." The experimental fact underlying this statement is that our ordinary methods of measuring quantities of heat in reality measure quantities of thermal energy. When two substances at different temperatures are mixed, the quantity remaining constant, provided that due allowance is made for external work done and for external loss of heat, is the total quantity of energy. Heat is a form of energy merely because the thing we measure and call heat is really a quantity of energy. Apart from considerations of practical convenience, we might equally well have agreed to measure a quantity of heat in accordance with Carnot's principle, by the external work done in a cycle per degree fall. Heat would then not be a form of energy, but would possess all the properties postulated for caloric. The caloric measure of heat follows directly from Carnot's principle, just as the energy measure follows from the law of conservation of energy. But the term *heat* has become so closely associated with the energy measure that it is necessary to employ a different term, *caloric*, to denote the simple measure of a quantity of heat as opposed to a quantity of heat energy. The measurement of heat as caloric is precisely analogous to the measure of electricity as a quantity of electric fluid. In the case of electricity, the quantity measure is more familiar than the energy measure, because it is generally simpler to measure electricity by its chemical and magnetic effects as a quantity of fluid than as a quantity of energy. The units for which we pay by electric meter, however, are units of energy, because the energy supplied is the chief factor in determining the cost of production, although the actual quantity of fluid supplied has a good deal to do with the cost of distribution. Both methods of measurement are just as important in the theory of heat, and it seems a great pity that the natural measure of heat quantity is obscured in the elementary stages of exposition by regarding heat simply as so much energy. The inadequacy of such treatment makes itself severely felt in the later stages.

Since Carnot's principle was adopted without material modification into the mechanical theory of heat, it was inevitable that Carnot's caloric, and his solution for the work done in a finite cycle, should sooner or later be rediscovered. Caloric reappeared first as the "thermo-dynamic function" of Rankine, and as the "equivalence value of a transformation" in the equations of Clausius; but it was regarded rather as the quotient of heat energy by temperature than as possessing any special physical significance. At a later date, when its importance was more fully recognized, Clausius gave it the name of *entropy,* and established the important property that its total quantity remained constant in reversible heat exchanges, but always increased in an irreversible process. Any process involving a decrease in the total quantity of entropy was impossible. Equivalent propositions with regard to the possibility or impossibility of transformations had previously been stated by Lord Kelvin in terms of the dissipation of available energy. But, since Carnot's solution had been overlooked, no one at the time seems to have realized that entropy was simply Carnot's caloric under another name, that heat could be measured otherwise than as energy, and that the increase of entropy in any irreversible process was the most appropriate measure of the quantity of heat generated. Energy so far as we know must always be associated with something of a material nature acting as carrier, and there is no reason to believe that heat energy is an exception to this rule. The tendency of the kinetic theory has always been to regard entropy as a purely abstract mathematical function, relating to the distribution of the energy, but having no physical existence. Thus it is not a quantity of anything in the kinetic theory of gases, but merely the logarithm of the probability of an arrangement. In a similar way, some twenty years ago the view was commonly held that electric phenomena were due merely to strains in the ether, and that the electric fluids had no existence except as a convenient means of mathematical expression. Recent discoveries have enabled us to form a more concrete conception of a charge of electricity, which has proved invaluable as a guide to research. Perhaps it is not too much to hope that it may be possible to attach a similar conception with advantage to caloric as the measure of a quantity of heat.

It has generally been admitted in recent years that some independent measure of heat quantity as opposed to heat energy is required, but opinions have differed widely with regard to the adoption of entropy as the quantity factor of heat. Many of these objections have been felt rather than explicitly stated, and are therefore the more difficult to answer satisfactorily. Others arise from the difficulty of attaching any concrete conception of a quantity of something to such a vague and shadowy mathematical function as entropy. The answer to the question "What is caloric?" must necessarily be of a somewhat speculative nature. But it is so necessary for the experimentalist to reason by analogy from the seen to the unseen, that almost any answer, however crude, is better than none at all. The difficulties experienced in regarding entropy as a measure of heat quantity are more of an academic nature, but may be usefully considered as a preliminary in attempting to answer the more fundamental question.

The first difficulty felt by the student in regarding caloric as the measure of heat quantity is that when two portions of the same substance, such as water, at different temperatures are mixed, the quantity of caloric in the mixture is greater than the sum of the quantities in the separate portions. The same difficulty was encountered by Carnot from the opposite point of view. The two portions at different temperatures represented a possible source of motive power. The question which he asked himself may be put as follows: "If the total quantity of caloric remained the same when the two portions at different temperatures were simply mixed, what had become of the motive power wasted?" The answer is that caloric is generated, and that the quantity generated is such that its energy is the precise equivalent of the motive power which might have been obtained if the transfer of heat had been effected by means of a perfect engine working without generation of caloric. The caloric generated in wasting a difference of temperature is the necessary and appropriate measure of the quantity of heat obtained by the degradation of available motive power into the less available or transformable variety of heat energy.

The processes by which caloric is generated in mixing substances at different temperatures, or in other cases where available motive power is allowed to run to waste, are generally of so turbulent a character that the steps of the process can not be followed, although the final result can be predicted under given conditions from the energy principle. Such processes could not be expected *a priori* to throw much light on the nature of caloric. The familiar process of conduction of heat through a body, the parts of which are at different temperatures, while equally leading to the generation of a quantity of caloric equivalent to the motive power wasted, affords better promise of elucidating the nature of caloric, owing to the comparative simplicity and regularity of the phenomena, which permit closer experimental study. The earliest measurements of the relative conducting powers of the metals for heat and electricity showed that the ratio of the thermal to the electric conductivity was nearly the same for all the pure metals, and suggested that, in this case, the carriers of heat and electricity were the same. Later and more accurate experiments showed that the ratio of the conductivities was not constant, but varied nearly as the absolute temperature. At first sight this might appear to suggest a radical difference between the two conductivities, but it results merely from the fact that heat is measured as energy in the definition of thermal conductivity, whereas electricity is measured as a quantity of fluid. If thermal conductivity were defined in terms of caloric or thermal fluid, the ratio of the two conductivities would be constant with respect to temperature almost, if not quite, within the limits of error of experiment. On the hypothesis that the carriers are the same for electricity and heat, and that the kinetic energy of each carrier is the same as that of a gas molecule at the same temperature, it becomes possible, on the analogy of the kinetic theory of gases, to calculate the actual value of the ratio of the conductivities. The value thus found agrees closely in magnitude with that given by experiment, and may be regarded as confirming the view that the carriers are the same, although the hypotheses and analogies invoked are somewhat speculative.

When the electrons or corpuscles of negative electricity were discovered it was a natural step to identify them with the carriers of energy, and to imagine that a metal contained a large number of such corpuscles, moving in all directions, and colliding with each other, and with the metallic atoms, like the molecules of a gas on the kinetic theory. If the mass of each carrier were $1/1700$ of that of an atom of hydrogen, the velocity at 0° C. would be about sixty miles a second, and would be of the right order of magnitude to account for the observed values of the conductivities of good conductors, on the assumption that the number of negative corpuscles was the same as the number of positive metallic atoms, and that the mean free path of each corpuscle was of the same order as the distance between the atoms. The same hypothesis served to give a qualitative account of thermo-electric phenomena, such as the Peltier and Thomson effects, and of radiation and absorption of heat, though in a less satisfactory manner. When extended to give a consistent account of *all* the related phenomena, it would appear that the number of free corpuscles required is too large to be reconciled, for instance, with the observed values of the specific heat, on the assumption that each corpuscle possesses energy of translation equal to that of a gas molecule at the same temperature.

Sir J. J. Thomson has accordingly proposed and discussed another possible theory of metallic conduction, in which the neutral electric doublets present in the metal are supposed to be continually interchanging corpuscles at a very high rate. Under ordinary condition these interchanges take place indifferently in all directions, but under the action of an electric field the axes of the doublets are supposed to become more or less oriented, as in the Grotthus-chain hypothesis of electrolytic conduction, producing a general drift or current proportional to the field. This hypothesis, though fundamentally different from the preceding or more generally accepted view, appears to lead to practically the same relations, and is in some ways preferable, as suggesting possible explanations of difficulties encountered by the first theory in postulating so large a number of free negative corpuscles. On the other hand, the second theory requires that each neutral doublet should be continually ejecting corpuscles at the rate of about 10^{15} per second. There are probably elements of truth in both theories, but, without insisting too much on the exact details of the process, we may at least assert with some confidence that the corpuscles of caloric which constitute a current of heat in a metal are very closely related to the corpuscles of electricity, and have an equal right to be regarded as constituting a material fluid possessing an objective physical existence.

If I may be allowed to speculate a little on my own account (as we are all here together in holiday mood, and you will not take anything I may say too seriously), I should prefer to regard the molecules of caloric, not as being identical with the corpuscles of negative electricity, but as being neutral doublets formed by the union of a positive and negative corpuscle, in much the same way as a molecule of hydrogen is formed by the union of two atoms. Nothing smaller than a hydrogen atom has yet, so far as I know, been discovered with a positive charge. This may be merely a consequence of the limitations of our experimental methods, which compel us to employ metals to so large an extent as electrodes. In the symmetry of nature it is almost inconceivable that the positive corpuscles should not exist, if only as the other end of the Faraday-tube or vortex-filament representing a chemical bond. Professor Bragg has identified the X or γ rays with neutral corpuscles traveling at a high velocity, and has maintained this hypothesis with brilliant success against the older view that these rays are not separate entities, but merely thin, spreading pulses in the ether produced by the collisions of corpuscles with matter. I must leave him to summarize the evidence, but if neutral corpuscles exist, or can be generated in any way, it should certainly be much easier to detach a neutral corpuscle from a material atom or molecule than to detach a corpuscle with a negative charge from the positive atom with which it is associated. We should therefore expect neutral corpuscles to be of such exceedingly common and universal occurrence that their very existence might be overlooked, unless they happened to be traveling at such exceptionally high velocities as are associated with the γ rays. According to the pulse theory, it is assumed that all γ rays travel with the velocity of light, and that the enormous variations observed in their penetrative power depend simply on the thickness of the pulse transmitted. On the corpuscular theory, the penetrative power, like that of the α and β rays, is a question of size, velocity, and electric charge. Particles carrying electric charges, like the α and β rays, lose energy in producing ions by their electric field, perhaps without actual collision. Neutral or γ rays do not produce ions directly, but dislodge either γ rays or β rays from atoms by direct collisions, which are comparatively rare. The β rays alone, as C. T. R. Wilson's photographs show, are responsible for the ionization. Personally, I have long been a convert to Professor Bragg's views on the nature of X rays, but even if we regard the existence of neutral corpuscles as not yet definitely proved, it is, I think, permissible to assume their existence for purposes of argument, in order to see whether the conception may not be useful in the interpretation of physical phenomena.

If, for instance, we assume that these neutral corpuscles or molecules of caloric exist in conductors and metallic bodies in a comparatively free state of solution, and are readily dissociated into positive and negative electrons owing to the high specific inductive capacity of the medium, the whole theory of metallic conduction follows directly on the analogy of conduction in electrolytic solutions. But, whereas in electrolytes the ions are material atoms moving through a viscous medium with comparatively low velocities, the ions in metallic conductors are electric corpuscles moving with high velocities more after the manner postulated in the kinetic theory of gases. It is easy to see that this theory will give similar numerical results to the electronic theory when similar assumptions are made in the course of the work. But it has the advantage of greater latitude in explaining the vagaries of sign of the Hall effect, and many other peculiarities in the variation of resistance and thermo-electric power with temperature. For good conductors, like the pure metals, we may suppose, on the electrolytic analogy, that the dissociation is practically complete, so that the ratio of the conductivities will approach the value calculated on the assumption that all the carriers of heat are also carriers of electricity. But in bad conductors the dissociation will be far from complete, and it is possible to see why, for instance, the electric resistance of cast iron should be nearly ten times that of pure iron, although there is comparatively little difference in their thermal conductivities. The numerical magnitude of the thermo-electric effect, which is commonly quoted in explanation of the deviation of alloys from the electronic theory, is far too small to produce the required result; and there is little or no correspondence between the thermo-electric properties of the constituents of alloys and the variations of their electric conductivities.

One of the oldest difficulties of the material theory of heat is to explain the process of the production of heat by friction. The application of the general principle of the conservation of energy leads to the undoubted conclusion that the thermal energy generated is the equivalent of the mechanical work spent in friction, but throws little or no light on the steps of the process, and gives no information with regard to the actual nature of the energy produced in the form of heat. It follows from the energy principle that the quantity of caloric generated in the process is such that its total energy at the final temperature is equal to the work spent. If a quantity of caloric represents so many neutral molecules of electricity, one can not help asking where they came from, and how they were produced. It is certain that in most cases of friction, wherever slip occurs, some molecules are torn apart, and the work spent is represented in the first instance by the separation of electric ions. Some of these ions are permanently separated as frictional electricity, and can be made to perform useful work; but the majority recombine before they can be effectively separated, leaving only their equivalent in thermal energy. The recombination of two ions is generally regarded simply as reconstituting the original molecule at a high temperature, but in the light of recent discoveries we may perhaps go a step further. It is generally admitted that X or γ rays are produced by the sudden stoppage of a charged corpuscle, and Lorentz, in his electron theory of radiation, has assumed that such is the case however low the velocity of the electron. A similar effect must occur in the sudden stoppage of a pair of ions rushing together under the influence of their mutual attraction. Rays produced in this way would be of an exceedingly soft or absorbable character, but they would not differ in kind from those produced by electrons except that their energy, not exceeding that of a pair of ions, would be too small to produce ionization, so that they could not be detected in the usual way. If the X rays are corpuscular in their nature, we can not logically deny the corpuscular character even to the slowest moving rays. We know that X rays continually produce other X rays of lower velocity. The final stage is probably reached when the average energy of an X corpuscle or molecule of caloric is the same as that of a gas molecule at the same temperature, and the number of molecules of caloric generated is such that their total energy is equal to the work originally spent in friction.

In this connection it is interesting to note that Sir J. J. Thomson, in a recent paper on "Ionization by Moving Particles," has arrived, on other grounds, at the conclusion that the character of the radiation emitted during the recombination of the ions will be a series of pulses, each pulse containing the same amount of energy and being of the same type as very soft X rays. If the X rays are really corpuscular, these definite units or quanta of energy generated by the recombination of the ions bear a close resemblance to the hypothetical molecules of caloric.

It may be objected that in many cases of friction, such as internal or viscous friction in a fluid, no electrification or ionization is observable, and that the generation of caloric can not in this case be attributed to the recombination of ions. It must, however, be remarked that the generation of a molecule of caloric requires less energy than the separation of two ions; that, just as the separation of two ions corresponds with the breaking of a chemical bond, so the generation of one or more molecules of caloric may correspond with the rupture of a physical bond, such as the separation of a molecule of vapor from a liquid or solid. The assumption of a molecular constitution for caloric follows almost of necessity from the molecular theories of matter and electricity, and is not inconsistent with any well-established experimental facts. On the contrary, the many relations which are known to exist between the specific heats of similar substances, and also between the latent heats, would appear to lead naturally to a molecular theory of caloric. For instance, it has often been noticed that the molecular latent heats of vaporization of similar compounds at their boiling points are proportional to the absolute temperature. It follows that the molecular latent caloric of vaporization is the *same* for all such compounds, or that they require the same number of molecules of caloric to effect the same change of state, irrespective of the absolute temperatures of their boiling points. From this point of view one may naturally regard the liquid and gaseous states as conjugate solutions of caloric in matter and matter in caloric respectively. The proportion of caloric to matter varies regularly with pressure and temperature, and there is a definite saturation limit of solubility at each temperature.

One of the most difficult cases of the generation of caloric to follow in detail is that which occurs whenever there is exchange of heat by radiation between bodies at different temperatures. If radiation is an electro-magnetic wave-motion, we must suppose that there is some kind of electric oscillator or resonator in the constitution of a material molecule which is capable of responding to the electric oscillations. If the natural periods of the resonators correspond sufficiently closely with those of the incident radiation the amplitude of the vibration excited may be sufficient to cause the ejection of a corpuscle of caloric. It is generally admitted that the ejection of an electron may be brought about in this manner, but it would evidently require far less energy to produce the emission of a neutral corpuscle, which ought therefore to be a much more common effect. On this view, the conversion of energy of radiation into energy of caloric is a discontinuous process taking place by definite molecular increments, but the absorption or emission of radiation itself is a continuous process. Professor Planck, by a most ingenious argument based on the probability of the distribution of energy among a large number of similar electric oscillators (in which the entropy is taken as the logarithm of the probability, and the temperature as the rate of increase of energy per unit of entropy), has succeeded in deducing his well-known formula for the distribution of energy in full radiation at any temperature; and has recently, by a further extension of the same line of argument, arrived at the remarkable conclusion that, while the absorption of radiation is continuous, the emission of radiation is discontinuous, occurring in discrete elements or quanta. Where an argument depends on so many intricate hypotheses and analogies the possible interpretations of the mathematical formulæ are to some extent uncertain; but it would appear that Professor Planck's equations are not necessarily inconsistent with the view above expressed that both emission and absorption of radiation are continuous, and that his *elementa quanta*, the energy of which varies with their frequency, should rather be identified with the molecules of caloric, representing the conversion of the electro-magnetic energy of radiation into the form of heat, and possessing energy in proportion to their temperature.

Among the difficulties felt rather than explicitly stated, in regarding entropy or caloric as the measure of heat quantity, is its awkward habit of becoming infinite, according to the usual approximate formulæ, at extremes of pressure or temperature. If caloric is to be regarded as the measure of heat quantity, the quantity existing in a finite body must be finite, and must vanish at the absolute zero of temperature. In reality there is no experimental foundation for any other conclusion. According to the usual gas formulæ it would be possible to extract an infinite quantity of caloric from a finite quantity of gas by compressing it at constant temperature. It is true that (even if we assumed the law of gases to hold up to infinite pressures, which is far from being the case) the quantity of caloric extracted would be of an infinitely low order of infinity as compared with the pressure required. But, as a matter of fact, experiment indicates that the quantity obtainable would be finite, although its exact value can not be calculated owing to our ignorance of the properties of gases at infinite pressures. In a similar way, if we assume that the specific heat as ordinarily measured remains constant, or approaches a finite limit at the absolute zero of temperature, we should arrive at the conclusion that an infinite quantity of caloric would be required to raise the temperature of a finite body from 0° to 1° absolute. The tendency of recent experimental work on specific heats at low temperatures, by Tilden, Nernst, Lindemann and others, is to show, on the contrary, that the specific heats of all substances tend to vanish as the absolute zero is approached and that it is the specific capacity for caloric which approaches a finite limit. The theory of the variation of the specific heats of solids at low temperatures is one of the most vital problems in the theory of heat at the present time, and is engaging the attention of many active workers. Professor Lindemann, one of the leading exponents of this work, has kindly consented to open a discussion on the subject in our section. We are very fortunate to have succeeded in securing so able an exponent, and shall await his exposition with the greatest interest. For the present I need only add that the obvious conclusion of the caloric theory bids fair to be completely justified.

A most interesting question, which early presented itself to Rumford and other inquirers into the caloric theory of heat, was whether caloric possessed *weight*. While a positive answer to this question would be greatly in favor of a material theory, a negative answer, such as that found by Rumford, or quite recently by Professor Poynting and Phillips, and by Mr. L. Southerns working independently, would not be conclusively against it. The latter observers found that the change in weight, if any, certainly did not exceed 1 in 10^8 per 1° C. If the mass of a molecule of caloric were the same as that generally attributed to an electron, the change of weight, in the cases tested, should have been of the order of 1 in 10^7 per 1° C., and should not have escaped detection. It is generally agreed, however, that the mass of the electron is entirely electro-magnetic. Any such statement virtually assumes a particular distribution of the electricity in a spherical electron of given size. But if electricity itself really consists of electrons, an argument of this type would appear to be so perfectly circular that it is questionable how much weight should be attached to it. If the equivalent mass of an electron in motion arises solely from the electromagnetic field produced by its motion, a neutral corpuscle of caloric should not possess mass or energy of translation as a whole, though it might still possess energy of vibration or rotation of its separate charges. For the purpose of mental imagery we might picture the electron as the free or broken end of a vortex filament, and the neutral corpuscle as a vortex ring produced when the positive and negative ends are united; but a mental picture of this kind does not carry us any further than the sphere coated with electricity, except in so far as either image may suggest points for experimental investigation. In our ignorance of the exact mechanism of gravity it is even conceivable that a particle of caloric might possess mass without possessing weight, though, with the possible exception of the electron, nothing of the kind has yet been demonstrated. In any case it would appear that the mass, if any, associated with a quantity of caloric must be so small that we could not hope to learn much about it by the direct use of the balance.

The fundamental property of caloric, that its total quantity can not be diminished by any known process and that it is not energy but merely the vehicle or carrier of energy, is most simply represented in thought by imagining it to consist of some indestructible form of matter. The further property, that it is always generated in any turbulent or irreversible process, appears at first sight to conflict with this idea, because it is difficult to see how anything indestructible can be so easily generated. When, however, we speak of caloric as being generated, what we really mean is that it becomes associated with a material body in such a way that we can observe and measure its quantity by the change of state produced. The caloric may have existed previously in a form in which its presence could not be detected. In the light of recent discoveries we might suppose the caloric generated to arise from the disintegration of the atoms of matter. No doubt some caloric is produced in this way, but those corpuscles that are so strongly held as to be incapable of detection by ordinary physical methods require intense shocks to dislodge them. A more probable source of caloric is the ether, which, so far as we know, may consist entirely of neutral corpuscles of caloric. The hypothesis of a continuous ether has led to great difficulties in the electro-magnetic theory of light and in the kinetic theory of gases. A molecular, or cellular-vortex, structure appears to be required. According to the researches of Kelvin, Fitzgerald and Hicks, such an ether can be devised to satisfy the requirements of the electro-magnetic theory without requiring it to possess a density many times greater than that of platinum. So far as the properties of caloric are concerned, a neutral pair of electrons would appear to constitute the simplest type of molecule, though without more exact knowledge of the ultimate nature of an electric charge it would be impossible to predict all its properties. Whether an ether composed of such molecules would be competent to discharge satisfactorily all the onerous functions expected from it, may be difficult to decide, but the inquiry, in its turn, would probably throw light on the ultimate structure of the molecule.

Without venturing too far into the regions of metaphysical speculation, or reasoning in vicious circles about the nature of an electric charge, we may at least assert with some degree of plausibility that material bodies under ordinary conditions probably contain a number of discrete physical entities, similar in kind to X rays or neutral corpuscles, which are capable of acting as carriers of energy, and of preserving the statistical equilibrium between matter and radiation at any temperature in virtue of their interchanges with electrons. If we go a step further and identify these corpuscles with the molecules of caloric, we shall certainly come in conflict with some of the fundamental dogmas of the kinetic theory, which tries to express everything in terms of energy, but the change involved is mainly one of standpoint or expression. The experimental facts remain the same, but we describe them differently. Caloric has a physical existence, instead of being merely the logarithm of the probability of a complexion. In common with many experimentalists, I can not help feeling that we have everything to gain by attaching a material conception to a quantity of caloric as the natural measure of a quantity of heat as opposed to a quantity of heat energy. In the time at my disposal I could not pretend to offer you more than a suggestion of a sketch, an apology for the possibility of an explanation, but I hope I may have succeeded in conveying the impression that a caloric theory of heat is not so entirely unreasonable in the light of recent experiment as we are sometimes led to imagine.

H. L. Callendar

THE PROBLEM OF MECHANICAL FLIGHT

HISTORICAL RÉSUMÉ

The scientific period in aviation began in 1809 when Sir George Cayley published in *Nicholson's Journal* the first complete mechanical theory of the aeroplane, in which he put clearly in evidence the fundamental principle of sustention obtained by velocity. This memoir passed unnoticed until unearthed some sixty years later by Pénaud. Following Cayley there was a long unfruitful interval in which fell the projected aeroplane of Henson in 1842–43, the attempts at gliding by Le Bris in 1856, and the biplane gliders of Wenham in 1866. At the end of the Franco-Prussian war interest in heavier-than-air flying machines was revived, and the Société française de Navigation aérienne was from 1872 on composed of a number of investigators engaged in the conquest of the air. The history of their endeavors is found in "L'Aéronaute." Among them was Alphonse Pénaud, a young mechanic whose early death prevented him from pushing his researches to their logical end. Pénaud was less isolated than Cayley and one of his memoirs was crowned by the Académie des Sciences. He constructed the first toy aeroplane, with the propeller in the rear and driven by a rubber band. This apparatus flew for an appreciable time, *utilizing motive energy which it carried with it,* and this property differentiates very sharply the experiment of Penaud from those of his predecessors, in which was realized only a fall more or less retarded by the air.

The German Lilienthal followed Penaud, and from 1891 studied the equilibrium, maneuvering and landing of gliders, falling to his death on his two thousandth flight, August 9, 1896. In this country the French engineer Chanute and the American Langley had meanwhile been experimenting and developing the laws of aerodynamics, Langley's work going as far back as 1887 and continuing until his unsuccessful attempts at flight in 1903. In 1891 he published[1] the results of his researches, and definitely stated that it was possible to construct machines which would give such velocity to inclined surfaces that bodies indefinitely heavier than air could be sustained upon it and moved through it with great speed.

By the end of the nineteenth century efforts to build aeroplanes had become numerous. Sir Hiram Maxim in England and Ader in France both constructed machines and made attempts to fly them. Maxim built in 1890–95 a flying machine with 557 square meters of surface and 3,640 kilograms weight, which was damaged before leaving the ground and abandoned. The "Avion" of Ader was tested on the field of Satory in 1897 before the representatives of the French War Department, but its performance led the department to withdraw its support and experiments were discontinued. Langley as early as 1896 had designed and built a small steam-driven model aerodrome weighing about 13 kilograms, and on May 6 of that year he flew it some 1,200 meters over the waters of the Potomac. The quarter-size model of his large man-carrying aerodrome flew successfully about 1,000 feet near Widewater, Va., on August 8, 1903, but the large machine itself, carrying Mr. Manly, was injured in launching

[1] "Experiments in Aerodynamics," Smithsonian Contributions to Knowledge, Vol. 27, 1891.

from the top of a houseboat on October 17, 1903, and wrecked in a second attempt on December 8 of that same year.

With this ended sixteen years of effort on the part of Langley to attain mechanical flight, and his long period of fruitful scientific achievement closed with failure due primarily to lack of funds. The report[2] of Major Macomb to the War Department concerning the tests made on the Potomac is interesting and illuminating.

After describing the attempted launching on October 7 and the subsequent wrecking of the great aerodrome on December 8, Major Macomb closes with the following paragraphs:

Having reached the present stage of advancement in its development, it would seem highly desirable, before laying down the investigation, to obtain conclusive proof of the possibility of free flight, not only because there are excellent reasons to hope for success, but because it marks the end of a definite step toward the attainment of the final goal.

In the meantime, to avoid any possible misunderstanding, it should be stated that even after a successful test of the present great aerodrome, designed to carry a man, we are still far from the ultimate goal, and it would seem as if years of constant work and study by experts, together with the expenditure of thousands of dollars, would still be necessary before we can hope to produce an apparatus of practical utility on these lines.

The War Department had made two allotments of $25,000 each to Langley to further his experiments, one in 1898 and the second in 1899. The large aerodrome was completed in July of 1903, the long delay being due to Langley's inability to secure a suitable motor, which he finally had to design. The tests referred to above were made in the fall of 1903 and on March 3, 1904, the Board of Ordnance and Fortifications stated[3] that it was "not prepared to make an additional allotment at this time for continuing the work." All material was left in Langley's possession for such future experiments as he might wish to make.

[2] Langley, "Memoir on Mechanical Flight," p. 276, Smithsonian Contributions to Knowledge, Vol. 27, 1911.

[3] Langley, "Memoir," p. 278.

On November 14, 1908, the board again reported:[4]

Doctor Langley considered it desirable to continue the experiments, but the Board deemed it advisable, largely in view of the adverse opinions expressed in Congress and elsewhere, to suspend operations in that direction.

The persistent misrepresentations of the public press caused Langley to publish the following statement.

Smithsonian Institution,
Washington, D. C.,
August 19, 1903.

To the Press: The present experiments being made in mechanical flight have been carried on partly with funds provided by the Board of Ordnance and Fortification and partly from private sources, and from a special endowment of the Smithsonian Institution. The experiments are carried on with the approval of the Board of Regents of the Smithsonian Institution.

The public's interest in them may lead to an unfounded expectation as to their immediate results, without the explanation which is here briefly given.

These trials, with some already conducted with steam-driven flying machines, are believed to be the first in the history of invention where bodies, far heavier than air itself, have been sustained in the air for more than a few seconds by purely mechanical means.

On my previous trials, success has only been reached after initial failures, which alone have taught the way to it, and I know no reason why the prospective trials should be an exception.

It is possible, rather than probable, that it may be otherwise now, but judging them from the light of past experience, it is to be regretted that the enforced publicity which has been given to these initial experiments, which are essentially experiments and nothing else, may lead to quite unfounded expectations.

It is the practice of all scientific men, indeed of all prudent men, not to make public the results of their work till these are certain. This consideration, and not any desire to withhold from the public matters in which the public is interested, has dictated the policy thus far pursued here. The fullest publicity, consistent with the national interest (since these recent experiments have for their object the development of a machine for war

[4] Langley, "Memoir," p. 279.

purposes), will be given to this work when it reaches a stage which warrants publication.

(Signed) S. P. LANGLEY

Like many men of his kind Langley seems to have had that passionate sense of privacy which resents alike the curiosity of the public and the sensationalism of the newspapers. The antagonistic attitude of the press gave a character of finality to experiments which to Langley himself were but members of a long series bringing him each year nearer the goal. Had his health and strength remained to combat the hostility of press and public, he would in all probability have gone on to success, undeterred by criticism and misunderstanding. To such patient and unremitting labor as his is owed the accomplished fact of mechanical flight. He began his investigations at a time when even progressive men of science thought flying a wild dream, and a large part of that exact investigation which transformed vague ideas into scientific knowledge is due directly to him. His work is measured not solely by his contributions, but much more by the unswerving advance in a field of scientific inquiry in which no road was marked.

The spirit of the man is made evident by his steadfast refusal to entertain propositions made him to assist in the development of the aerodrome provided arrangements were made for later commercialization. He had given his time and energy without hope of remuneration, and even when no assistance could be obtained from any other source and success seemed but a step away, he could not bring himself to capitalize his scientific work, although his age was such that any delay in achieving success increased the probability of his not living to see it. He died February 27, 1906, about two years before the Wright brothers astonished the world by their feats in sustained flying in 1908.

II

FUTURE OF THE AEROPLANE

The Problem of Velocity.—The mechanical theory of the behavior of the aeroplane is built on the principle that in steady horizontal flight the normal thrust on the sustaining surface is proportional to the area, to the square of the relative velocity, and to the sine of the angle of attack, or:

(1) $$F = kSV^2 \sin i,$$

where, *for small values of i*, k is a constant for a given surface under constant atmospheric conditions, S is the area of the sustaining surface, V its velocity relative to the air stream, and i the angle of attack. For uniform horizontal flight i equals the fixed inclination of the sustaining surface to the horizontal axis of the aeroplane, and is a constant of the machine.

The vertical component of this normal thrust—*the lift*—must equal the weight of the whole machine, and denoting the lift by L and the weight by W, there follows:

(2) $$L = W = kSV^2 \sin i \cos i = kSV^2 i \text{ (nearly)}.$$

The *sustaining resistance* R is given by the horizontal component of the normal thrust, whence:

(3) $$R = kSV^2 \sin^2 i = kSV^2 i^2 \text{ (nearly)}.$$

The power P required to overcome the sustaining resistance R is:

(4) $$P = RV = kSV^3 i^2.$$

From (2) and (4) we have:

(5) $$V^2 = W/kSi, \quad P = W^2/ksV.$$

These two relations lead to the very important result that the *velocity of sustention* V increases as the angle of attack decreases, and the power required to drive the sustaining plane against its own resistance decreases as the velocity increases. The advantage of flying at high velocity and "close to the wind" is at once evident.

In these relations, however, the resistance offered by the motor and its accessory parts including the framework—*the passive resistance*—has been neglected. The power required to overcome this is proportional to the cube of the velocity and the "equivalent surface" presented to the air stream, and is enormously increased at high velocities. It is at once evident that for a given machine there is a maximum velocity beyond which the motor can not drive it. The *problem of velocity* may then be stated as follows: Required a motor which shall be capable of driving itself and accessory parts, including framework and sustaining surface, against its own resistance at high velocity. Undoubtedly the problem so stated is too simplified, but the motor must be capable of developing at least that power.

The solution of the problem does not lie in the construction of larger motors homothetic to those now in use, for the "equivalent resisting surface" is increased at the same time that the power is augmented, and if the calculated attainable speed be based on the assumptions of power proportional to weight, weight proportional to cube of linear dimensions, and "equivalent resisting surface" proportional to square of linear dimensions, then the power must be increased 512 fold in order to double the speed. In particular, if a motor developing 100 horse power could drive an aeroplane at a speed of 100 kilometers an hour, a homothetic motor developing 800 horse power would, under the conditions stated above, drive its aeroplane at 126 kilometers per hour.

These assumptions are at the present time well within the range of consideration, and give a general idea of what to expect along the line of motor development.

The solution of the problem may, however, be in quite another direction: in the construction of steam line body forms for the aeroplanes of the future. Stream line forms offer a minimum resistance at high velocities, and their attainment is the immediate problem of the future so far as the development of high speeds is concerned. The architecture of the aeroplane is thus seen to be of paramount importance, and it is in that direction that future advance may be looked for.

The Problem of Stability.—More important than the attainment of high velocity is the realization of stability in flight. At the present time it is to a very large extent dependent on the personal skill of the aviator, and however great this may become, it is highly desirable that the aeroplane should be rendered *automatically stable* in straightaway flight at least, if for no other reason than to leave the aviator free to attend to such other matters as may legitimately engage his attention.

The distribution of the mass of the aeroplane about its center of gravity is at once felt in the sensitiveness of the response which the machine accords to disturbing forces. If the aeroplane be disturbed by some external force so that the angle of attack becomes α instead of i, it will oscillate about its position of equilibrium under the equation:

$$(6) \qquad I\frac{d^2\alpha}{dt^2} = \sigma V^2(\alpha - i) - 2hV\frac{d\alpha}{dt},$$

where I is the moment of inertia about a horizontal gravity axis perpendicular to the direction of motion, and σ and h are constants. This equation shows at once that if the sustaining plane pitches slightly, the *initial* oscillation will be the more violent the smaller the value of I and hence the closer the heavy masses to the center of gravity G. A more complete discussion of equation (6), however, shows that the motion defined by it, under the initial conditions

$$\alpha_0 \neq i, \quad \left(\frac{d\alpha}{dt}\right)_0 = 0, \quad t = 0,$$

dies down the more rapidly the smaller the value of I, and hence the initial disadvantage of violent oscillation is more than compensated by the rapidity with which these oscillations disappear under *damping.* From the standpoint of stability the best type of machine would seem to be that in which the heavy masses are concentrated in the neighborhood of the center of gravity. Such a distribution, however, produces a machine very sensitive to external disturbances and too small a value of I will produce too great an initial value of α, and equation (6) will no longer define the motion. Theoretically, at least, under equation (6) the moment of inertia of a given machine might be made so small that the damping would produce a periodic motion, but practically the initial displacement would then be so large for a small force that the orientation would no longer be in the neighborhood of the equilibrium orientation. It is necessary that some method of keeping the initial displacement small under a disturbing force be devised, but it is equally undesirable that the moment of inertia be materially increased by the introduction of the stabilizing device. This consideration alone would serve to discard all methods of stabilization making use of heavy masses, such as heavy gyroscopes or pendulums, and an effective stabilizing device would have to call into play the stabilizing surface by means of a mechanism of transmission operated by a light mass sensitive to light disturbing forces, such as a small but rapidly rotating gyroscope. Direct stabilization by a heavy pendular mass, for instance, is a purely chimerical procedure.

G. O. James
Washington University

EARLY MAN IN SOUTH AMERICA

Five years ago the Bureau of American Ethnology published a bulletin on Skeletal Remains Suggesting, or Attributed to, Early Man in North America, based on the researches of Dr. Ales Hrdlička, Curator of Physical Anthropology in the U. S. National Museum. There is to appear shortly in similar form, under the title of Early Man in South America, a résumé of the investigations of Dr. Hrdlička, in collaboration with Mr. W. H. Holmes, head curator of the Department of Anthropology in the U. S. National Museum, Mr. Bailey Willis, of the U. S. Geological Survey, and Messrs. Fred. Eugene Wright and Clarence E. Fenner, of the Geophysical Laboratory of the Carnegie Institution of Washington.

Even before the completion of his report on ancient man in North America, Dr. Hrdlička became interested in the evidence bearing on the corresponding problem in South America, and subsequently, at the suggestion of Mr. W. H. Holmes, he was sent by the secretary of the Smithsonian Institution to visit Argentina for the purpose of making a study at first hand of the available material and an investigation of the most promising regions.

In view of the important position occupied by geology in studies of this nature, Mr. Bailey Willis of the U. S. Geological Survey was chosen to accompany Dr. Hrdlička.

The chief objects of the expedition were: the examination of the skeletal remains relating to early man, in Brazil and Argentina; the study of the principal localities and deposits from which these finds came; and, if possible, the collection of osseous, archeologic and other specimens bearing on the subject of man's antiquity. It was hoped that thorough investigation on the ground would enable the explorers to form more definite conclusions concerning the finds than the literature relating to them warranted, and that possibly by means of new discoveries additional light would be thrown on the whole subject of early man in South America, especially in Argentina.

The party reached Argentina early in May, 1910. Dr. Hrdlička spent two months in that country, while Mr. Willis remained somewhat longer, nearly all of this time being given to the researches recorded in the report. The work was greatly facilitated by several of the local men of science, and the authors express warm appreciation for the valuable assistance thus rendered. During the first part of the stay in Argentina, Dr. Hrdlička devoted his time to the study of the available skeletal material attributed to ancient man, found in the various local museums, while Mr. Willis examined the various samples of baked earth, and other objects believed to have been associated with the activities of prehistoric man. Several localities in Buenos Aires where local exposures could be studied, including the drydock where the "Diprothomo" skull had been found some time before, were carefully examined. On May 24 the party set out for the coast where important specimens had been discovered, and a few days later were joined at Mar del Plata, by the late Professor Florentino Ameghino and his brother Carlos, who assisted the expedition materially, accompanying Dr. Hrdlička and Mr. Willis for more than three weeks from place to place on the coast, and to several inland points of interest.

After the completion of this general survey, Dr. Hrdlička visited the valley of the Rio Negro whence came several fossil crania many years ago, while Mr. Willis proceeded to

Arroyo Siasgo and Alvear, to study the geology of these territories and several specimens of baked earth supposed to be the product of ancient human industry. Early in July, both explorers met again in Buenos Aires, and after finishing their work in that region started for Ovejero, a locality in northwestern Argentina that has come into prominence in the last few years through its yield of human bones; they also visited Tacuman, San Juan and Mendoza. Dr. Hrdlička then proceeded to Peru while Mr. Willis returned to Buenos Aires.

The researches occupied nearly three months. Every specimen relating to ancient man that could be found was examined and every important locality was investigated. Unfortunately the general results of the inquiry are not in harmony with claims previously made by the various authors who reported the several finds. On the contrary, the conclusion was reached that to the present time the evidence is unfavorable to the hypothesis of man's great antiquity, especially as to the existence of very early predecessors of the Indian in South America; nor does it sustain the theories of the evolution of man in general, or even that of an American race alone, in the southern continent. The facts gathered attest everywhere merely the presence of the already differentiated and relatively modern American Indian. This should not be taken as a categorical denial of the existence of early man in South America, however improbable such a conclusion may now appear; but the position is maintained that the final acceptance of the evidence on this subject can not be justified until there is accumulated a mass of strictly scientific observations, requisite in kind and volume, to establish a proposition of so great importance.

The expedition secured numerous geological, paleontological and anthropological specimens, some of which throw light on the question under investigation. All these specimens have been deposited in the United States National Museum for further study and exhibition.

THE NEW ALLEGHENY OBSERVATORY

THE new Allegheny Observatory, situated in Riverview Park, Pittsburgh, was dedicated on the afternoon of Wednesday, August 28, in the presence of the members of the Astronomical and Astrophysical Society of America, and of many of the Pittsburgh friends of the institution. The principal instruments of the new observatory are a 13-inch visual refractor, a 30-inch reflector (a memorial to James Edward Keeler), and a 30-inch photographic refractor (a memorial to William Thaw and his son, William Thaw, Junior). The last of these telescopes is not quite completed, as the objective remains to be supplied. Addresses were made by Dr. John A. Brashear, chairman of the observatory committee; by Dr. Samuel Black McCormick, chancellor of the University of Pittsburgh, of which the observatory forms the astronomical department; by Dr. Frank Schlesinger, director of the Allegheny Observatory, and by Professor E. C. Pickering, director of the Harvard College Observatory. Mrs. William Reed Thompson, the daughter of William Thaw and the sister of William Thaw Junior, closed the exercises with the unveiling of the memorial tablet on the Thaw telescope.

SCIENTIFIC NOTES AND NEWS

DR. W J McGEE, known for his contributions to geology, anthropology and the conservation of natural resources, died at Washington on September 5, aged fifty-nine years.

DR. M. PLANCK, professor of theoretical physics in the University of Berlin, has been elected permanent secretary of the mathematical and physical section of the Berlin Academy of Sciences.

DR. JEAN MASCART, of the Paris Observatory, has been appointed director of the Lyons Observatory in succession to M. André.

IT was stated in last week's issue of SCIENCE that the friends and former students of Professor Wilhelm Wundt had presented to him on his eightieth birthday a foundation for the University of Leipzig. The disposition of the foundation was left to Professor Wundt, who has decided to use it to equip in the psychological laboratory at Leipzig a department for psychological acoustics and phonetics.

Professor Émile Borel, of the University of Paris, and director of the *Revue du Mois* and of the *Nouvelle Collection Scientifique,* who is to be present at the opening of the Rice Institute of Houston, Texas, will be the guest of the University of Illinois part of the week beginning October 14.

Dr. R. Tait McKenzie, professor of physical education at the University of Pennsylvania, has executed a large bronze medallion known as "The Joy of Effort" which has been presented to the Swedish nation by the American committee on the Olympic games and is now being mounted in granite in the wall of the stadium at Stockholm.

Dr. Henry Fox, professor of biology at Ursinus College, has resigned to accept the position of assistant in entomology in the Bureau of Entomology. For the present he will be engaged at the permanent station of Lafayette, Indiana.

Dr. R. Kent Beattie, recently professor of botany in the State College of Washington, Pullman, Wash., has accepted a position as expert in the office of forest pathology of the Bureau of Plant Industry.

Mr. Harold Bryant, M.S. (Calif.), has been reappointed fellow in applied zoology in the University of California on the State Fish and Game Foundation for the continuance of an investigation into the economic status of the meadow lark, begun last year under the same appointment. Mr. Frank C. Clarke, M.S. (Calif.), has been appointed to a similar fellowship for the investigation of the problem of deer conservation in the state of California. The state commission and the department of zoology at the university cooperate in the investigation with a view to determining a scientific basis for legislation.

T. A. Bendrat, who has been engaged in teaching economic geology at the University of North Carolina, sailed from New York on the *Saramacca* on June 12 for Venezuela, where he will enter an engagement as reconnaisance geologist for at least two years.

While Professor E. J. McCaustland, Mem. Am. Soc. C. E., was prosecuting some water-power investigations on the Deschutes River in Oregon the boat in which he and two men were traveling was swamped in the rapids and his two companions were drowned. Professor McCaustland clung to the boat and was carried nearly a mile down the river and finally flung upon a rock in mid-stream. Three hours later he was rescued from this position by some men, who succeeded in getting a line out to him and who pulled him to the shore. The drowned men had both been selected to handle the boat on account of their long experience in river work. Both were excellent swimmers, but were unable to make shore on account of eddies and cross-currents.

Professor Wilhelm Ostwald, formerly of the University of Leipzig, will deliver a course of lectures at the University of Illinois during the week beginning October 13. The titles of the lectures will be announced later.

The following provisional program of lectures before the Harvey Society, New York, for the season of 1912–13 has been arranged:

October 5—Professor Max Rubner, University of Berlin: "Modern steam sterilization."

November 9—Professor Joseph Erlanger, George Washington University: "The localization of impulse initiation and conduction in the heart."

November 23—Professor G. N. Stewart, Western Reserve University: "The rate of the blood flow and the vasomotor reflexes in disease."

December 14: Professor F. B. Mallory, Harvard University: "The infectious lesions of blood vessels."

January 18—Major J. J. Russell, U.S.A.: "The prevention of typhoid fever."

February 15—Professor Theodore C. Janeway, Columbia University: "Nephritic hypertension: clinical and experimental studies."

March 1—Professor Edward G. Conklin, Princeton University: "The size of organisms and their constituent parts in relation to longevity, senescence and rejuvenescence."

March 22—Professor John Howland, Johns Hopkins University: "The scientific basis for the artificial feeding of infants."

The Society of the Liebig Museum held its second meeting in the Liebig Laboratory at Giessen. It will be remembered that this society purchased last year the laboratory for fifteen thousand dollars. Many gifts connected with the life of the great chemist have been received.

Rev. G. W. Taylor, curator of the Canadian Marine Biological Station at Departure Bay, near Nanaimo, B. C., died at his residence near the station on August 22. Mr. Taylor has been most widely known in the fields of entomology and conchology, but his interests, particularly as a collector, extended over the whole range of systematic zoology.

M. Lucien Lévy, the distinguished French mathematician, has died at the age of fifty-nine years.

Dr. François Alphonse Forel, known for his researches on the Lake of Geneva and on glaciers, died at Berne on August 8, aged seventy-one years.

Mr. Alexander Dean, a British authority on horticulture, has died at the age of eighty years.

Mr. A. Brothers, of Manchester, the author of several works and inventions concerned with photography, has died at the age of eighty-six years.

Dr. Andrew Wilson, lecturer on physiology and health under the George Combe trust and the author of numerous books and articles for the popularization of science, died on August 25.

We are informed that a number of thefts of platinum from laboratories have occurred recently, and as a warning to those responsible we are requested to publish the following description of the thief: "A German Jew, with a German accent; age, about 40 years; height, 5 feet 8 inches; weight, about 200 pounds; peculiar shaped head; bald; clean shaven; large, short neck; heavy jaws; dark complected; dark hair and eyes; intelligent; when last seen wore blue serge suit and panama hat, and representing himself to be a book and magazine agent."

We learn from *Nature* that the collection of foreign Lepidoptera bequeathed by the late Mr. H. T. Adams, of Enfield, has been received at the Natural History Branch of the British Museum. It is contained in 68 cabinets, and is stated to comprise about 150,000 specimens. The estimated value of the collection is between £40,000 and £45,000.

The congress before adjournment passed an amendment to the food and drug act which the president has signed, making it illegal "If its package or label shall bear or contain any statement, design, or device regarding the curative or therapeutic effect of such article, or any of the ingredients or substances contained therein, which is false and fraudulent." It will be remembered that the act of 1906 declared that a drug is misbranded "the package or label of which shall bear any statement . . . which shall be false or misleading in any particular . . ."; but the supreme court by a majority of five to three decided that this did not refer to false statements regarding the curative effect of a drug.

The congress also passed the bill carrying out the fur seals treaty, including a closed season for five years in the Pribilof Islands.

The fifteenth International Congress on Hygiene and Demography will, as has already been announced, be held at Washington, D. C., September 23–28, 1912, with Mr. Taft as honorary president. The president of the congress is Dr. Henry P. Walcott, of Massachusetts; the secretary, Dr. John S. Fulton, Senate Annex, Washington, D. C. Thirty-two foreign countries have accepted the invitation of this government to take part. The German Medical Society of New York will hold a reception on the evening of September 18 in honor of the German and Austrian physicians who will come to this country to attend the congress.

At the International Otological Congress held in Boston, under the presidency of Dr. Clarence J. Blake, it was decided to hold the tenth congress at Halle, Germany, in 1915. The officers elected were: *President,* Dr. Alfred Denker, of Halle; *Vice-president,* Dr. Alexander B. Randall, of Philadelphia; *Secretary and Treasurer,* Dr. Henry O. Reik, of Baltimore.

Mr. James B. Brady, of New York, has, it is reported, given the sum of $220,000 to the Johns Hopkins Hospital, Baltimore, for the establishment of a ward for the treatment of diseases of the kidney.

The annual meeting of the Association of Military Surgeons of the United States will be held in Baltimore, from October 1 to 5, under the presidency of Surgeon Charles P. Wertenbaker, U. S. Public Health Service.

UNIVERSITY AND EDUCATIONAL NEWS

The new physics building at the University of Iowa, costing $225,000 exclusive of equipment, is now completed and will be used from the opening of the college year.

Dr. Shadworth Hollway Hodgson, the distinguished philosophical author, who died on June 3, aged eighty years, has bequeathed his philosophical laboratory to Corpus Christi College, Oxford, and his general library to Rugby School. He bequeathed £500 to each institution to defray the cost of incidental expenses.

M. E. Solvay will give $2,000 a year for three years to the Laboratory of Physical Chemistry of the Berlin University to assist the researches on which Professor Nernst is engaged.

Ira D. Cardiff, Ph.D., professor of botany in Washburn College, has resigned to accept the position of professor of plant physiology in the Washington State College at Pullman.

Dr. Sabrazès, associate professor at the laboratory of the Faculté de médecine de Bordeaux, has been appointed professor of pathology and anatomy at the same school, in place of Dr. Coyne, who has retired.

Professor Lucien Cayeux, formerly professor of general geology at the National School of Mines at Paris, has been elected to the chair of "The Natural History of Inorganic Bodies" at the Collège de France, left vacant by the death of Michel-Lévy.

DISCUSSION AND CORRESPONDENCE

A REMEDY WORSE THAN THE DISEASE

To the Editor of Science: In your issue of August 9, an article by Professor J. S. Kingsley announces various changes in the rules of zoological nomenclature proposed by certain Austrian and German zoologists, and to be submitted to the next zoological congress for approval. He inferentially asks the signatures of those interested in zoology as a backing for the proposed changes. In view of the total demoralization of zoological nomenclature which would follow the adoption of these changes (and I do not see the name of a single expert in such matters among those cited in their favor by Professor Kingsley) I feel bound to offer some comments.

I may incidentally remark that it is the past modification in a similar manner of the original British Association rules by over hasty and ill-informed action, that is responsible for ninety-nine out out of every hundred of the present difficulties. Moreover, my own experience in my own field of study leads me to believe it probable that Professor Kingsley's communication greatly exaggerates the difficulties for professional naturalists of the present state of affairs. The people who find themselves in trouble are not the men who really do modern work in systematic zoology, but are men of a past generation who are annoyed by unfamiliar names, teachers relying on out-of-date text-books, some amateurs without access to recent literature and the body of anatomists, morphologists and others, not systematists, who do not like to be bothered by nomenclature at all, but wish to get names for their material without working for them or asking some one who is by way of knowing.

I would be the last to deny that there are some real difficulties, and that it would be wise to remedy them, but the authors of this outcry have not indicated the right way to bring it about. On the contrary, in some respects it is calculated to increase the difficulties tenfold, to undo good work that is already accepted by the generality of students (for I take it for granted that the new laws are intended to be *ex post facto*), and to introduce such a mass of uncertainty, doubt and confusion as could never be remedied. The probable result would be that most experts would refuse to accept the new system and without their acquiescence nothing good could be hoped for.

The nature of nomenclature in science is such that to be stable it must be arbitrary. Past experience as well as common sense prove that such matters of controversy left to individual opinion are never finally settled. Individuals must fall back on a general rule of action. Let us examine the proposals. We shall find them containing both good and evil. The first section of the Austrian circular is stated to restrict nomenclature to binomial works, in which I heartily concur, and which, with certain arbitrary exceptions (like Brisson), has always been the rule. The second "provides that when a species has once been removed from a genus it shall not be considered as the type of the genus in any future revision." Here we have uncertainty piled upon doubt. When is a species "removed from a genus"? What constitutes "removal"? If a species *is* the type of a genus and some one "removes" it, does it for that reason lose its character? If an error has been committed by some blundering tyro, is it to remain forever uncorrected? Here is arbitrariness with a vengeance!

The third section proposes that the decision of questions in nomenclature be taken away from experts and settled by popular vote. Anybody willing to subscribe five dollars may vote. It needs no comment.

The German Zoological Society begins with an eminently rational proposition, *i. e.*, that special cases be arbitrarily settled according to their merits by a committee of experts. In the list of examples there are few which call for dissent, though it may be remarked that *Terebratula* and *Liothyrina* are different groups, and that the species now referred to *Liothyrina* are not members of the traditional *Terebratula;* also that the entire group of students of the Brachiopoda, without a dissenting voice so far as I know, are in accord on this point. If the change be made it would in this case be solely for the benefit of those unwilling to give up a familiar blunder.

Their second proposition opens the way to chaos. Who is to decide when a given situation "will lead to lasting confusion or error"? Hardly the authors of this circular.

The third proposition returns to sanity. "Certain works are not to be considered in the determination of questions of priority." If these are settled, case by case, by expert committees, the rule is one I have long advocated; but it should not be decided by a vote of heterogeneous subscribers of five dollars. Looking over the list submitted as examples we find many of which the exclusion would probably meet with general approval; some which would probably be by expert vote retained. It should not be in any case decided without grave consideration of the effect on existing systematics.

The fourth proposition relapses into an appeal for chaos again. "Articles in encyclopedias, popular works of travel, journals of hunting and fishing, catalogues, garden journals, agricultural periodicals, political and local newspapers and other non-scientific journals which are without influence in systematic science" are to be ignored.

No one even moderately acquainted with the history of systematic zoology could make such a proposition as this, except in the haste which obscures clear thinking. All the above denounced journals which have influenced systematic science are, of course, *not* to be ignored (by the terms of the last clause of the proposal), but who cares what is done to those which have not? Systematists are only concerned with those which have; and which by the language of this self-contradictory announcement are endorsed, though not intentionally. Accepting the real intent of this proposal it seems impossible that those who propose it can have any conception of the new confusion and uncertainty it would create.

To sum up, the only practicable method of settling disputed questions of this sort is that adopted by the International Commission as now established. Each case to be decided on its merits, and decided by experts, after proper consideration of the effect of the decision. To run with the unthinking crowd is no part of scientific business. If the present method has its drawbacks, it has also accomplished a preponderating amount of good service.

Wm. H. Dall

August 16, 1912

SCIENTIFIC BOOKS

Founders of Modern Psychology. By G. Stanley Hall. New York and London, D. Appleton & Company. 1912. Pp. ix + 471.

Of the twelve years from 1870 to 1882, the author spent nearly six as a student in Germany. The first triennium, ending with the year 1873, was devoted to philosophy, and it was at this period that I came under the influence of those men [Zeller, Lotze, Fechner and von Hartmann] characterized in the first four chapters. After coming home and teaching what I had learned from these masters and others for six years, during which my interest in more scientific methods and modes of approach grew, especially after the first edition of Wundt's "Psychologie" in 1874 and as a pupil of James and Bowditch, I passed a second triennium in Germany, to which period Wundt and Helmholtz [the subjects of the two concluding chapters] belong.

Six years in Germany, without the haunting oppression of the doctor's thesis!—such was our author's opportunity, and he made the most of what was offered. He heard Hegel from the lips of Michelet; he sat with Paulsen in Trendelenburg's seminary; he undertook work of research in Ludwig's laboratory, with von Kries as partner; he experimented with Helmholtz; he was the first American student in Wundt's newly founded laboratory of psychology; he discussed psychophysics with Fechner, the creator of psychophysics; he was present at Heidenhain's early essays in hypnotism; he attended those lavishly experimental lectures of Czermak, where hecatombs of dogs were sacrificed on the altar of science and "in one case even a horse was introduced to show heart action"; he was informed by Zöllner of the marvels wrought by Slade, and later he saw those same marvels performed "at evening parties in Berlin by a young docent in physics"; he followed courses in theology, metaphysics, logic, ethics, psychology, the philosophy of religion—in physics, chemistry, biology, physiology, anatomy, neurology, anthropology, psychiatry; he frequented clinic and seminary, laboratory and lecture; and he roamed afield as far as Paris on the west and Vienna on the east. *Non cuivis homini contingit adire Corinthum!* But Dr. Hall made the journey twice over, and took his fill of the intellectual feast.

The six men to whom the present volume is devoted have already been named. First in order stands Eduard Zeller (1814–1908), who began his public life as a protestant theologian—he married the daughter of F. C. Baur, the founder of the Tübingen school—but is better known to the present generation of scholars as the historian of Greek philosophy and the dreaded examiner at the university of Berlin, where he became professor of philosophy in 1872. Zeller is followed by Rudolf Hermann Lotze (1817–1881), the greatest name in German philosophy between Herbart and Wundt, who spent his working life in Göttingen (1844–1881) and died within a few months of his call to Berlin. Next comes Gustav Theodor Fechner (1801–1887), physicist and mystic, whose philosophy was held during his lifetime in ill repute, though its by-product brought him enduring fame as the founder of psychophysics. Fourth upon the list stands Karl Robert Eduard von Hartmann (1842–1906), the apostle of pessimism and of the unconscious, an invalid and recluse, who lived his days with philosophy and music in a cottage just outside Berlin, and who enjoyed the popularity that has fallen in later times to Haeckel and to Nietzsche. Next comes Helmholtz, unquestionably the greatest figure in the book. Last of all stands Wundt, the *Altmeister* of experimental psychology, still happily with us, though now on the eve of his eightieth birthday.

To understand the choice of these six men —for who beside the author would count Zeller and von Hartmann among the founders of modern psychology?—we must understand something of Dr. Hall's own training and temperament. Passing to Germany from a denominational American college, he took with him an enthusiastic interest in the philosophy and psychology of religion—an interest that prompted his publication in 1872–3 of I. A. Dorner's "System of Theology" and that, persisting to the present time, has led him to establish a *Journal of Religious Psychology*, and to interpret the great philosophical systems as Freudian sublimations of religious conviction. It is significant that the names of Graf and Kuenen, to whom was due the renascence of the higher criticism in the sixties, do not appear in his pages: yet he is catholic enough to appreciate Dorner and Zeller and Delitzsch, Pfleiderer and Lazarus. So far, we may suppose, Germany continued and enriched a mode of thought which was already familiar. But there was surprise in store: the "narrow, formal, rather dry curriculum" of the college was to give way to "a great and sudden revelation of the magnitude of the field of science." And what a revelation! Those were the great days of Darwinism; the days of Haeckel, of the "Generelle Morphologie" and the "Natürliche Schöpfungsgeschichte" and the biogenetic law, of the "Descent of Man" itself! Biology was thinking in great sweeps of thought; evolution was the key to world-riddles; there was no cloud upon the horizon to warn men of the minute specialization and laborious experimentation that were to come. It is small wonder that Dr. Hall became the enthusiastic champion of a genetic psychology; and it is small wonder that his geneticism bears the indelible impress of its date of origin. This contemporary Darwinian enthusiasm is, indeed, the fount and source of most of the critical judgments passed in the book.

Along with the interest in religion and the possession by the genetic idea go two other marked characteristics: the zeal of the reformer, the exhorter, the practical educator, and a sort of perpetual youth, with an unsatiated appetite for intellectual novelties. The former is apparent throughout the work; the latter is seen in the writer's almost boyish absorption in new movements—in Freudianism, in Bergson, in the introspective departures of the Würzburg school—and crops out in the oddest personal fashion, as when one great man is censured for a stay-at-home life, and another is credited with a habit of vacation-trips. Every chapter begins in this way with a biographical sketch, which in fact makes us acquainted with the author no less than with his subject. Then follows an analysis of the subject's principal works, with more or less of running commentary and criticism; the exposition seems to be taken, in the main, from lecture-notes of the seventies and eighties, while the comment represents the writer's more mature position. Finally, the sketch ends with a general appreciation and a selected bibliography. The first five portraits in Dr. Hall's gallery occupy some sixty pages apiece; Wundt, who evidently and quite naturally has given him the greatest trouble, fills no less than a hundred and fifty.

Dr. Hall delegated to an assistant "the burden of revising and correcting the entire manuscript of the book, and seeing it through the press." It is no blame to the assistant that the slips and inconsistencies of statement, inevitable in composition of this kind, have not been removed. But in regard to what are somewhat unfairly termed printer's errors, I am afraid that blame is deserved: the avoidable mistakes of word and phrase are both numerous and grotesque.

E. B. Titchener

Enzymes. Six lectures under the Herter Lectureship Foundation, at the University and Bellevue Hospital Medical College. By Otto Cohnheim. New York, John Wiley and Sons. 1912.

This publication brings before an enlarged audience the forceful lectures upon the subject of the enzymes, which delighted those who were privileged to hear them two years ago. The book is simply written and the views therein expressed, even as regards the author's own discoveries and beliefs, are conservatively stated. It is a trustworthy guide to modern knowledge, and will be of especial value to those who have no desire to master the larger monographs on the subject. The author gives the historical development which finally leads to the establishment of the identity of the enzymes pepsin and rennin, and suggests that curdling of milk is best explained by supposing that the curd is formed by the precipitation of a proteose of casein which is insoluble in acids and in water containing calcium salts. Cohnheim sadly but humanly remarks, "We meet here with one of the unfortunate cases in which science in stepping forward obliterates and renders useless the hard and skilful work of a whole generation of prominent men."

Of interest are the oxidative enzymes laccase and tyrosinase, which convert the aromatic cleavage products of protein into coloring matters which gradually become black. Laccase, of the lac tree, gives rise to oxyurushic acid which gives the brilliant black luster to the lacquer manufactured in Japan and China. Tyrosinase causes the production of coloring matter in the hemolymph of certain butterflies, it also attacks the proteins of the dead or dying leaves in the autumn and causes the brilliant coloring of the Indian summer; it is found in the ink-bag of the sepia; and to it may be ascribed the transformation of tyrosin into homogentisic acid in the human disease of alcaptonuria.

Written primarily for medical students, the above selections are merely an indication of the breadth of view from which the subject is surveyed.

The country should be grateful to Professor Cohnheim that, through the means of the Herter Lectureship Foundation, he has been able to add to its literature a treatise such as is "The Enzymes."

Graham Lusk

SPECIAL ARTICLES

SYMPTOMATIC DEVELOPMENT OF CANCER

So little is apparently known of the external symptoms of internal cancer in its early stages that any contribution of attentive observation would seem useful. The following personal case is fairly paralleled by another which need not be described; and the parallelism would seem to give some weight to the inferences.

During my second expedition to Seriland in the autumn of 1895 my party had occasion to climb Sierra Seri, the culminating range of the region. After leaving the wagon camp the party moved on foot (with two pack animals) over some 10 miles of gently upsloping plain to the foothills, where the real climb began; the pace taken was rather rapid and I was somewhat but not excessively tired on reaching the foothills, where the pack horses were to be sent back. Within a few minutes after starting the climb I observed a condition novel in my experience—*i. e.,* inability to lift the feet (especially the left) more than a few inches above the level at which I stood. There was no pain, scarcely any discomfort—merely the inability to raise the feet without help from the hands. Assuming it a manifestation of exhaustion, I halted the party for a time and ate lunch; but, on resuming, the condition almost immediately returned. Greatly puzzled, I abandoned the climb and started back with the Indian in charge of the pack horses, finding no difficulty in going downslope. Within fifteen minutes I was startled by a call from one of the remainder of the party making the climb, "El Gringo es muerto [The American is dead]." Even without explanation I knew this referred to W. D. Johnson, topographer of the expedition; and stimulated by the apparent tragedy I immediately turned to resume the climb to the point of the disaster—but despite the intense excitement, I had not climbed fifty steps before the former inability to lift the feet returned. So I remained in virtually helpless condition (sending my Indian up to the climbing party with specific inquiries) for perhaps half an hour; when the Indian returned with the gratifying intelligence that "El Gringo" had come to life and had gone on up the mountain—for it appeared that he had merely swooned under the stress of the long walk and the early stages of a stiff climb, and, recovering, had gone on with his accustomed persistence. This episode marked the first observed abnormality in locomotory powers which had been above the average.

The next noteworthy manifestation appeared during an expedition of 1900, when I frequently found myself unable to raise the left foot to the stirrup on mounting—indeed it became necessary generally to modify the attitude in mounting so as to permit giving a hitch upward to the left foot with the hand. Sometimes, too, on dismounting the left leg partially gave way; so that I acquired the habit of swinging out of the saddle in such a manner as to land on both feet. During subsequent months in office work I noticed an abnormal condition, though I failed at the time to associate it with that experienced in the field—*i. e.*, on rising after occupying my chair for a considerable time, either a sharp pain or a sensation of weakness was experienced in the left groin. This condition continued until the habit was acquired of rising with care and putting the weight at first wholly on the right foot.

In 1902 I noticed that the footfall sounds of my two feet as I walked the pavement were unlike; and I made considerable vain effort, sometimes with the help of friends, to find the reason for the asymmetry in movement indicated by the diversity in sound. This abnormality was not then associated with the abnormal conditions observed in field and office; but when within a year I noticed that the sole of the left shoe wore out twice as rapidly as that of the right I began to associate the several conditions, though without forming any idea as to cause.

In 1906 I suffered an epididymitis on the left; and in casting about for the cause of this attack my physician seemed so confident that it must be gonorrheal or syphilitic in origin (which I knew to be erroneous) that I gladly welcomed the occasion to have an expert blood examination made by a practitioner recently from a noted expert and school in London. The examination showed no trace of the infection suspected by the physician, but gained my confidence by detecting evidences of a typhoid fever through which I had passed some years previously; but it left the epididymitis totally unexplained.

About this time I made a trip through the Sierra Nevada region, largely in company with Gifford Pinchot, then Chief Forester, and J. A. Holmes, now Director of Mines; and in the course of the trip was much embarrassed by inability to climb or to ascend slopes of more than moderate degree—the trouble lying in the same inability to lift the feet first observed in Seriland.

In the autumn of 1909 while in field work in Washington state I noticed uncertainty in coordination of the control and movement of the left foot, especially in passing over slippery rocks or logs; and on one occasion suffered an accident of some severity due to a needless slip of the left foot. About this time also I noticed a slight bladder difficulty which continued increasingly for over a year—when treatment began for enlarged prostate. After preliminary examination and treatment of the conventional sort, prostatectomy was prescribed, and in April, 1911, I underwent the operation—which revealed a cancerous condition in which the carcinomatous tissue was of an exceptionally hard type, and too extended for complete extirpation. Recovery was tedious and complicated, and within a few weeks after leaving the hospital an epididymitis on the right developed—this time with little doubt in my mind as to the cause. The symptom of weakness and pain in the left groin also recurred with increased intensity, and a hitching gait was developed. The bladder never became completely normal; and in January, 1912, the lower intestine evidently became affected, producing assimilative difficulties of growing gravity.

In April, 1912—a year after the operation—a condition gradually developed on the tendons of the left knee similar to that first observed in the groin—the twinge of pain on sudden movement, inability to exercise full control, etc. The general burden on the system attending the abnormal development was noticed (without realization of the cause) about 1904, and increasingly thereafter.

Any significance this record may have lies merely in bringing out the association between a series of obscure and puzzling symptoms developed in the course of several years, which finally seem to have found explanation in the cancerous growth revealed well toward the end of the series.

W J McGee[1]

REVERSIBLE CHANGES IN PERMEABILITY PRODUCED BY ELECTROLYTES

According to one opinion permeability is a relatively fixed property of the cell and is altered only as the result of injury: the alteration is then irreversible.

Another view assumes that there are reversible changes in permeability which involve no injury and which may form a normal part of the activities of the cell. If such changes occur it is clear that they may control the course of metabolism. That permeability may be altered in this manner is suggested by a number of facts,[1] but their interpretation is too doubtful to place this view on a firm basis. It is highly important that its truth or falsity be established by rigorous proof. Such proof seems to be afforded by a series of experiments, some of which are described below.

The method pursued in these experiments has been described in a previous paper.[2] It consists in cutting disks of living tissue from fronds of the common kelp (*Laminaria*) and measuring their electrical conductivity in various solutions. Under the conditions of these experiments an increase or decrease of conductivity denotes a corresponding increase or decrease of permeability.

Upon transferriug the living tissue from sea water to pure sodium chloride of the same conductivity (and at the same temperature) an immediate increase of conductivity was observed. The conductivity continued to increase at a regular rate for about two hours. At the end of this time the conductivity of the tissue was equal to that of the same amount of sea water. At this point it remained stationary even when the tissue was replaced in sea water. This signifies that the tissue was dead.

In this case we are dealing with an irreversible change in permeability. It is natural to ask whether this change is not, up to a certain point, reversible. In order to test this, fresh living tissue was transferred from sea water to sodium chloride of the same conductivity (and at the same temperature); readings were then taken at intervals of two minutes. In the course of five minutes the resistance had fallen from 1,000 ohms to 850 ohms.[3] The tissue was then replaced in sea water and readings were taken at intervals of five minutes. In the course of five minutes the resistance rose to normal and remained unaltered until the following day, when the experiment was discontinued. This experiment was repeated many times under different conditions and with a variety of salts. The results were similar throughout.

In order to make certain that no injury resulted from the treatment with sodium chloride an experiment was performed to ascertain the effect of repeated treatments on the same lot of tissue. In one experiment the tissue was treated with sodium chloride until the resistance dropped from 1,020 ohms to 890 ohms and was then replaced in sea water, after which the resistance rose to 1,020 ohms; this was repeated daily on the same lot of tissue for fifteen days. On the tenth day the tissue began to show a falling off in resistance, which continued to the fifteenth day, when the experiment was discontinued. As this falling off was also shown by the control, which was kept in sea water throughout the experiment, it was not due to the sodium chloride, but to other causes.

The objection may be made that in this experiment the increase in conductivity was due to an increase in the number of sodium ions and that these may normally penetrate the cell more easily than the other ions of the sea water: it might therefore be unnecessary

[1] Dr. McGee died on September 5, 1912.—*Editor.*

[1] For a recent summary see Höber, "Physikalische Chemie der Zelle und Gewebe," Kap. 7 und 10, Dritte Auflage, 1911.

[2] Science, N. S., XXXV., p. 112, 1912.

[3] All the figures in this paper refer to readings taken at 18° C.

to assume any alteration in the normal permeability of the protoplasm. This supposition can not be correct, for experiments showed that the other ions of the sea water penetrate with about the same rapidity as those of sodium chloride, but in order to be absolutely sure of this point it was tested by employing in place of sea water a solution composed of 1,000 c.c. NaCl .52M plus 20 c.c. $CaCl_2$ .278M. In this solution the proportion of sodium ions to calcium ions is about 100 to 1, as is evident from the fact that both the .52M NaCl solution and the .278M $CaCl_2$ solution have the same conductivity (which is the same as that of the sea water). In this solution the conductivity of the tissue is about the same as in sea water. If we now transfer to NaCl .52M there will be an increase of about 2 per cent. in the number of sodium ions. Consequently (on the supposition that sodium ions penetrate more easily than the other ions of sea water) we may not expect an increase of more than 2 per cent. in the conductivity as long as the permeability remains unaltered. But if the increase is more than 2 per cent. it signifies a corresponding increase in permeability.

In the mixture of 1,000 c.c. NaCl .52M plus 20 c.c. $CaCl_2$ .278M the tissue was found to have a resistance of 1,020 ohms: after two hours the resistance was unaltered. The material was then transferred to NaCl .52M and left until the resistance fell to 860 ohms. It was then replaced in the mixture of NaCl and $CaCl_2$: the resistance soon rose to 1,020 ohms and remained unaltered for several hours; it was left in the mixture over night and on the following morning the resistance was still the same. It subsequently remained the same as that of the control which was kept in sea water throughout the experiment.

In order to find out how much of the resistance is due to living protoplasm the tissue was killed by exposing it for ten minutes to 2 per cent. formalin in sea water;[4] the resistance fell to 320 ohms. On subtracting this from the resistance observed when the tissue is alive we obtain approximately the resistance due to the living protoplasm; this may be called for convenience the *net resistance*, while the resistance before the subtraction is made may be called the *gross resistance*. The net resistance in this experiment was accordingly $1{,}020 - 320 = 700$ ohms before treatment with NaCl and $860 - 320 = 540$ ohms after treatment with NaCl; the net conductance before treatment with NaCl was therefore $1 \div 700 = .001428$ mho. and after treatment with NaCl $1 \div 540 = .001852$, a gain of 29.7 per cent. (the gain in gross conductance was 18.6 per cent.).[5]

It is therefore evident that there has been a very marked increase in permeability which is completely reversible.

Electrolytes may also cause a reversible decrease in permeability. The simplest way of demonstrating this is by means of the following very striking experiment. The resistance of a cylinder of living tissue in sea water was found to be 750 ohms. It was tested an hour later and found to be the same. Sufficient lanthanum nitrate was then added in solid form to make its concentration[6] in the sea water about .01M. After five minutes the resistance rose to 900 ohms. As the conductance of the dead tissue was found (at the end of the experiment) to be 315 ohms, the net resistance before the addition of lanthanum was $750 - 315 = 435$ ohms and the net conductance $1 \div 435 = .0023$ mho. After treatment with lanthanum nitrate the net resistance was $900 - 315 = 585$ ohms and net conductance $1 \div 585 = .001709$, a loss of 25.6 per cent.

[4] Check experiments showed that killing in this way has the same effect on the resistance of the tissue as killing it by means of heat or by iodine vapor or by allowing it to die a natural death.

[5] Owing to the fact that the cylinder of tissue was of the same size in each set of experiments a calculation of the specific resistivity and of the specific conductivity was unnecessary.

[6] The concentration was reduced by the precipitation of a small amount of lanthanum sulphate: this had practically no influence on the subsequent result, since the outcome is the same if we use in place of sea water a mixture of 1,000 c.c. NaCl . 52M + 20 c.c. $CaCl_2$. 278M, in which case no precipitate is formed. It should be noted that the addition of lanthanum chloride has the same effect as the addition of lanthanum nitrate.

In order to ascertain whether this change in permeability is reversible the tissue was replaced in sea water. In the course of an hour its resistance returned again to the original condition.[7] The experiment was then repeated three times on the same lot of material with the same result; it was then allowed to stand over night in sea water. On the following day there was no appearance of injury and its resistance was the same as that of the control which had remained in sea water throughout the experiment. The tissue was then placed in the sea water plus lanthanum and left until its resistance had increased about 150 ohms; it was then put back into sea water and left until the resistance fell to normal. This was repeated three times and the tissue was then allowed to stand over night in sea water. On the third, fourth and fifth days the same experiment was repeated four times. On the fifth day the tissue appeared to be in as good condition as the control and had a resistance which was slightly higher. There was therefore no reason to suspect that the changes in permeability had been attended by any injurious effect.

Similar experiments were performed in which calcium chloride was used in place of lanthanum nitrate. In this case 3.3 gm. anhydrous $CaCl_2$ were added to each 1,000 c.c. of sea water. Owing to the fact that the rise in resistance took place more slowly than when lanthanum was used, the experiment was performed twice on each of the five successive days. On the sixth day the material was in as good condition as the control and had the same resistance.

It is therefore evident that the permeability may be greatly decreased and then restored to the normal several times on five successive days without any trace of injury. Further experiments showed that the permeability may be alternately increased and decreased twice daily for five days without injury. The amount of increase and decrease was about the same as in the experiments just described.

[7] If the material is left in sea water plus lanthanum nitrate the increased resistance is maintained for a long time unaltered.

Experiments on dead tissue (killed by heat or by formalin or allowed to die a natural death) showed that the results described above are due entirely to the living cells.

A very marked decrease of permeability may be produced by a considerable variety of other salts.

The addition of these salts in solid form simultaneously increases the conductivity of the solution and decreases the conductivity of the tissue. This affords the most convincing proof that the change in the conductivity of the tissue in these experiments can not be due to any cause other than a change in permeability; for the concentration of the ions of the sea water remains unchanged, and if they were able to penetrate as freely as they did before the addition of the salt the resistance would not increase. It would, in fact, diminish on account of the increased conductivity of the solution held in the cell walls, as is clearly shown by experiments on dead tissue.

It may be remarked incidentally that these experiments effectually dispose of the possible objection that the current passes between the cells but not through them. Were this objection well founded the decrease in conductivity could be explained only as the result of a decrease in the size of the spaces between the cells. This decrease could not be brought about except by greatly reducing the thickness of the cell walls. Both macroscopic and microscopic measurements show most conclusively that this does not occur. The contrary effect would be produced by the addition of salts in solid form, for they would tend to produce plasmolysis and thereby to increase the space between the cells.

Results.—1. It is possible to cause rapid and very large changes in permeability by means of electrolytes.

2. These changes may consist in either an increase or a decrease in permeability.

3. Within wide limits these changes may be completely reversible and entirely devoid of injurious effects.

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ZOOLOGICAL GARDENS AND THE PRESERVATION OF FAUNA[1]

In thinking over possible subjects for this presidential address, I was strongly tempted to enter on a discussion of the logical methods and concepts that we employ in zoology. The temptation was specially strong to a Scot speaking in Scotland, that he should devote the hour when the prestige of the presidential chair secured him attention, to putting his audience right on logic and metaphysics. But I reflected that zoology is doing very well, however its logic be wavering, and that as all lines subtend an equal angle at infinity, it would be of small moment if I were to postpone my remarks on metaphysics. And so I am to essay a more modest but a more urgent theme, and ask you to consider the danger that threatens the surviving land-fauna of this globe. A well-known example may serve to remind you how swift is the course of destruction. In 1867, when the British Association last met at Dundee, there were still millions of bison roaming over the prairies and forests of North America. In that year the building of the Union Pacific, the first great transcontinental railway, cut the herd in two. The southern division, consisting itself of several million individuals, was wiped out between 1871 and 1874, and the practical destruction of the northern herd was completed between 1880 and 1884. At present there are only two herds of wild bison in existence. In the Yellowstone Park only about twenty individuals remained in 1911, the greater part of the

[1] Address of the president of the Zoological Section of the British Association for the Advancement of Science. Dundee, 1912.

herd having been killed by poachers. A larger number, over three hundred, still survive near the Great Slave Lake, and there are probably nearly two thousand in captivity, in various zoological gardens, private domains and state parks. It is only by the deliberate and conscious interference of man that the evil wrought by man has been arrested.

A second example that I may select is also taken from the continent of North America, but it is specially notable because it is sometimes urged, as in India, that migratory birds require no protection. Audubon relates that just a century ago passenger pigeons existed in countless millions, and that for four days at a time the sky was black with the stream of migration. The final extinction of this species has taken place since the last meeting of the association in Dundee. In 1906 there were actually five single birds living, all of which had been bred in captivity, and I understand that these last survivors of a prolific species are now dead, although the birds ranged in countless numbers over a great continent.

It would be futile to discuss in detail the precise agencies by which the destruction of animal life is wrought, or the pretexts or excuses for them. The most potent factors are the perfection of the modern firearm and the enormous increase in its use by civilized and barbarous man. Sometimes the pretext is sport, sometimes wanton destructiveness rules. The extermination of beasts-of-prey, the clearing of soil for stock or crops, the securing of meat, the commercial pursuit of hides and horns and of furs and feathers, all play their part. Farmers and settlers on the outskirts of civilization accuse the natives, and allege that the problem would be solved were no firearms allowed to any but themselves. Sportsmen accuse other sportsmen, whom they declare to be no real sportsmen, and every person whose object is not sport. The great museums, in the name of science, and the rich amateur collectors press forward to secure the last specimens of moribund species.

But even apart from such deliberate and conscious agencies, the near presence of man is inhospitable to wild life. As he spreads over the earth, animals wither before him, driven from their haunts, deprived of their food, perishing from new diseases. It is part of a general biological process. From time to time, in the past history of the world, a species favored by some happy kink of structure or fortunate accident of adaptability, has become dominant. It has increased greatly in numbers, outrunning its natal bounds, and has radiated in every possible direction, conquering woodland and prairies, the hills and the plains, transcending barriers that had seemed impassable, and perhaps itself breaking up into new local races and varieties. It must be long since such a triumphant progress was unattended by death and destruction. When the first terrestrial animals crept out of their marshes into the clean air of the dry land, they had only plants and the avenging pressure of physical forces to overcome. But when the amphibians were beaten by the reptiles, and when from amongst the reptiles some insignificant species acquired the prodigious possibility of transformation to mammals, and still more when amongst the mammals eutherian succeeded marsupial, carnivore the creodont and man the ape, it could have been only after a fatal contest that the newcomers triumphed. The struggle, we must suppose, was at first most acute between animals and their nearest inferior allies, as similarity of needs brings about the keenest competition, but it must afterwards have been extended against lower and lower occupants of the coveted territory.

The human race has for long been the dominant terrestrial species, and man has a wider capacity for adaptation to different environments, and an infinitely greater power of transcending geographical barriers than have been enjoyed by any other set of animals. For a considerable time many of the more primitive tribes, especially before the advent of firearms, had settled down into a kind of natural equilibrium with the local mammalian fauna, but these tribes have been first driven to a keener competition with the lower animals, and then, in most parts of the world, have themselves been forced almost or completely out of existence. The resourceful and aggressive higher races have now reached into the remotest parts of the earth and have become the exterminators. It must now be the work of the most intelligent and provident amongst us to arrest this course of destruction and to preserve what remains.

In Europe, unfortunately, there is little left sufficiently large and important to excite the imagination. There is the European bison which has been extinct in western Europe for many centuries, whilst the last was killed in east Prussia in 1755. There remains a herd of about seven hundred in the forests of Lithuania, strictly protected by the Tsar, whilst there are truly wild animals, in considerable numbers, in the Caucasus, small captive herds on the private estates of the Tsar, the Duke of Pless and Count Potocki, and a few individuals in various zoological gardens. There is the beaver, formerly widespread in Europe, now one of the rarest of living mammals, and lingering in minute numbers in the Rhone, the Danube, in a few Russian rivers and in protected areas in Scandinavia. The wolf and the bear have shrunk to the recesses of thick forests and the remotest mountains, gluttons to the most barren regions of the north. The chamois survives by favor of game laws and the vast inaccessible areas to which it can retreat, but the mouflon of Corsica and Sardinia and the ibex in Spain are on the verge of extinction. Every little creature, from the otter, wild cat and marten to the curious desman is disappearing.

India contains the richest, the most varied, and, from many points of view, the most interesting part of the Asiatic fauna. Notwithstanding the teeming human population it has supported from time immemorial, the extent of its area, its dense forests and jungles, its magnificent series of river valleys, mountains and hills have preserved until recent times a fauna rich in individuals and species. The most casual glance at the volumes by sportsmen and naturalists written forty or fifty years ago reveals the delight and wonder of travel in India so comparatively recently as the time when the association last met in Dundee. Sir H. H. Johnston has borne witness that even in 1895 a journey "through almost any part of India was of absorbing interest to the naturalist." All is changed now, and there seems little doubt but that the devastation in the wonderful mammalian fauna has been wrought chiefly by British military officers and civilians, partly directly, and partly by their encouragement of the sporting instincts of the Mohammedan population and the native regiments, although the clearing of forests and the draining of marshlands have played an important contributory part. The tiger has no chance against the modern rifle. The one-horned rhinoceros has been nearly exterminated in northern India and Assam. The magnificent gaur, one of the most splendid of living creatures, has been almost killed off throughout the limits of its range—southern India and the Malay

Peninsula. Bears and wolves, wild dogs and leopards are persecuted remorselessly. Deer and antelope have been reduced to numbers that alarm even the most thoughtless sportsmen, and wild sheep and goats are being driven to the utmost limits of their range.

When I speak of the fauna of Africa, I am always being reminded of the huge and pathless areas of the Dark Continent, and assured that lions and leopards, elephants and giraffe still exist in countless numbers, nor do I forget the dim recesses of the tropical forests where creatures still lurk of which we have only the vaguest rumor. But we know that south Africa, less than fifty years ago, was a dream that surpassed the imagination of the most ardent hunter. And we know what it is now. It is traversed by railways, it has been rolled over by the devastations of war. The game that once covered the land in unnumbered millions is now either extinct, like the quagga and the black wildebeeste, or its scanty remnant lingers in a few reserves and on a few farms. The sportsman and the hunter have been driven to other parts of the continent, and I have no confidence in the future of the African fauna. The mountains of the moon are within range of a long vacation holiday. Civilization is eating into the land from every side. All the great European countries are developing their African possessions. There are exploring expeditions, punitive expeditions, shooting and collecting expeditions. Railways are being pushed inland, water-routes opened up. The land is being patrolled and policed and taxed, and the wild animals are suffering. Let us go back for a moment to the Transvaal and consider what has happened since the Rand was opened, neglecting the reserves. Lions are nearly extinct. The hyena has been trapped and shot and poisoned out of existence. The eland is extinct. The giraffe is extinct. The elephant is extinct. The rhinoceros is extinct. The buffalo is extinct. The bontebok, the red hartebeeste, the mountain zebra, the oribi and the grysbok are so rare as to be practically extinct. And the same fate may at any time overtake the rest of Africa. The white man has learned to live in the tropics; he is mastering tropical diseases; he has need of the vegetable and mineral wealth that lie awaiting him, and although there is yet time to save the African fauna, it is in imminent peril.

When we turn to Australia with its fauna of unique zoological interest, we come to a more advanced case of the same disease. In 1909 Mr. G. C. Shortridge, a very skilled collector, working for the British Museum, published in the *Proceedings of the Zoological Society of London* the results of an investigation he had carried out on the fauna of western Australia south of the tropics, during the years 1904–1907. He gave a map showing the present and comparatively recent distribution for each of the species of marsupials and monotremes indigenous to that locality. West Australia as yet has been very much less affected by civilization than Queensland, New South Wales or Victoria, and yet in practically every case there was found evidence of an enormous recent restriction of the range of the species. Marsupials and monotremes are, as you know, rather stupid animals, with small powers of adaptation to new conditions, and they are in the very gravest danger of complete extinction. In the island of Tasmania, the thylacine or marsupial wolf, and the Tasmanian devil have unfortunately incurred the just hostility of the stock raiser and poultry farmer, and the date of their final extermination is approaching at a pace that must be reckoned by months rather than by years.

The development of the continent of North America has been one of the wonders of the history of the world, and we on this side of the Atlantic almost hold our breath as we try to realize the material wealth and splendor and the ardent intellectual and social progress that have turned the United States into an imperial nation. But we know what has happened to the American bison. We know the danger that threatens the pronghorn, one of the most isolated and interesting of living creatures, the Virginian deer, the mule-deer and the bighorn sheep. Even in the wide recesses of Canada, the bighorn, the caribou, the elk, the wapiti, the white mountain goat and the bears are being rapidly driven back by advancing civilization. In South America less immediate danger seems to threaten the jaguar and maned wolf, the tapirs and ant-eaters and sloths, but the energy of the rejuvenated Latin races points to a huge encroachment of civilization on wild nature at no distant date.

You will understand that I am giving examples and not a catalogue even of threatened terrestrial mammals. I have said nothing of the aquatic carnivores, nothing of birds or of reptiles or of batrachians and fishes. And to us who are zoologists, the vast destruction of invertebrate life, the sweeping out, as forests are cleared and the soil tilled, of innumerable species that are not even named or described, is a real calamity. I do not wish to appeal to sentiment. Man is worth many sparrows; he is worth all the animal population of the globe, and if there were not room for both, the animals must go. I will pass no judgment on those who find the keenest pleasure of life in gratifying the primeval instinct of sport. I will admit that there is no better destiny for the lovely plumes of a rare bird than to enhance the beauty of a beautiful woman. I will accept the plea of those who prefer a well-established trinomial to a moribund species. But I do not admit the right of the present generation to careless indifference or to wanton destruction. Each generation is the guardian of the existing resources of the world; it has come into a great inheritance, but only as a trustee. We are learning to preserve the relics of early civilizations, and the rude remains of man's primitive arts and crafts. Every civilized nation spends great sums on painting and sculpture, on libraries and museums. Living animals are of older lineage, more perfect craftsmanship and greater beauty than any of the creations of man. And although we value the work of our forefathers, we do not doubt but that the generations yet unborn will produce their own artists and writers, who may equal or surpass the artists and writers of the past. But there is no resurrection or recovery of an extinct species, and it is not merely that here and there one species out of many is threatened, but that whole genera, families and orders are in danger.

Now let me turn to what is being done and what has been done for the preservation of fauna. I must begin by saying, and this was one of the principal reasons for selecting the subject of my address, that we who are professional zoologists, systematists, anatomists, embryologists and students of general biological problems, in this country at least, have not taken a sufficiently active part in the preservation of the realm of nature that provides the reason for our existence. The first and most practical step of world-wide importance was taken by a former president of the British Association, the late Lord Salisbury, one of the few in the long roll of

English statesmen whose mind was attuned to science. In 1899 he arranged for a convention of the great powers interested in Africa to consider the preservation of what were curiously described as the "Wild Animals, Birds and Fish" of that continent. The convention, which did most important pioneer work, included amongst its members another president of this association, Sir Ray Lankester, whom we hold in high honor in this section as the living zoologist who has taken the widest interest in every branch of zoology. But it was confined in its scope to creatures of economic or of sporting value. And from that time on the central authorities of the great powers and the local administrators, particularly in the case of tropical possessions, seem to have been influenced in the framing of their rules and regulations chiefly by the idea of preserving valuable game animals. Defining the number of each kind of game that can be killed, charging comparatively high sums for shooting permits, and the establishment of temporary or permanent reserved tracts in which the game may recuperate, have been the principal methods selected. On these lines, narrow although they are, much valuable work has been done, and the parts of the world where unrestricted shooting is still possible are rapidly being limited. I may take the proposed new Game Act of our Indian Empire, which has recently been explained, and to a certain extent criticized, in the *Proceedings of the Zoological Society of London*, by Mr. E. P. Stebbing, an enlightened sportsman-naturalist, as an example of the efforts that are being made in this direction, and of their limitations.

The act is to apply to all India, but much initiative is left to local governments as to the definition of the important words "game" and "large animal." The act, however, declares what the words are to mean in the absence of such local definitions, and it is a fair assumption that local interpretations will not depart widely from the lead given by the central authority. Game is to include the following in their wild state: Pigeons, sandgrouse, peafowl, jungle-fowl, pheasants, partridges, quail, spurfowl, florican and their congeners; geese, ducks and their congeners; woodcock and snipe. So much for birds. Mammals include hares and "large animals" defined as "all kinds of rhinoceros, buffalo, bison, oxen; all kinds of sheep, goats, antelopes and their congeners; all kinds of gazelle and deer."

The act does not affect the pursuit, capture or killing of game by non-commissioned officers or soldiers on whose behalf regulations have been made, or of any animal for which a reward may be claimed from government, of any large animal in self-defence, or of any large animal by a cultivator or his servants, whose crops it is injuring. Nor does it affect anything done under license for possessing arms and ammunition to protect crops, or for destroying dangerous animals, under the Indian Arms Act. Then follow prohibitory provisions all of which refer to the killing or to the sale or possession of game or fish, and provisions as to licenses for sportsmen, the sums to be paid for which are merely nominal, but which carry restrictions as to the number of head that may be killed. I need not enter upon detailed criticism as to the vagueness of this act from the zoological point of view, or as to the very large loopholes which its provisions leave to civil and military sportsmen; these have been excellently set forth by Mr. Stebbing, who has full knowledge of the special conditions which exist in India. What I desire to point out is that it conceives of animals as game rather than as animals, and that it does not even contemplate the possibility of the protection of birds-of-prey and beasts-of-prey, and still less of the enormous numbers of species of animals that have no sporting or economic value.

Mr. Stebbing's article also gives a list of the very large number of reserved areas in India, which are described as "Game Sanctuaries." His explanation of them is as follows:

> With a view to affording a certain protection to animals of this kind (the elephant, rhinoceros, ruminants, etc.) and of giving a rest to species which have been heavily thinned in a district by indiscriminate shooting in the past, or by anthrax, drought, etc., the idea of the Game Sanctuary was introduced into India (and into other parts of the world) and has been accepted in many parts of the country. The sanctuary consists of a block of country, either of forest or of grassland, etc., depending on the nature of the animal to which sanctuary is required to be given; the area has rough boundaries such as roads, fire lines, nullahs, etc., assigned to it, and no shooting of any kind is allowed in it, if it is a sanctuary pure and simple; or the shooting of carnivora may be permitted, or of these latter and of everything else save certain specified animals.

Mr. Stebbing goes on to say that sanctuaries may be formed in two ways. The area may be automatically closed and reopened for certain definite periods of years, or be closed until the head of game has become satisfactory, the shooting on the area being then regulated, and no further closing taking place, save for exceptional circumstances. The number of such sanctuary blocks, both in British India and in the native states, will cause surprise and pleasure to most readers, and it can not be doubted but that they will have a large effect on the preservation of wild life. The point, however, that I wish to make is that in the minds of those who have framed the game act, and of those who have caused the making of the sanctuaries—as indeed in the minds of their most competent critics—the dominant idea has been the husbanding of game animals, the securing for the future of sport for sportsmen. I do not forget that there is individual protection for certain animals; no elephant, except a rogue elephant, may be shot in India, and there are excellent regulations regarding birds with plumage of economic value. The fact remains that India, a country which still contains a considerable remnant of one of the richest faunas of the world, and which also is probably more efficiently under the autocratic control of a highly educated body of permanent officials, central and local, than any other country in the world, has no provision for the protection of its fauna simply as animals.

The conditions in Africa are very different from those in India. The land is portioned out amongst many powers. The settled population is much less dense and the hold of the white settler and the white ruler is much less complete. The possibility of effective control of native hunters and of European travelers and sportsmen is much smaller, and as there are fewer sources of revenue, the temptation to exploit the game for the immediate development of the struggling colonies is much greater. Still, the lesson of the extinction of the South African fauna is being taken to heart. I have had the opportunity of going through the regulations made for the shooting of wild animals in Africa by this country, by our autonomic colonies, by France, Germany, Italy, Portugal and Belgium, and, with the limitation that they are directed almost solely towards the protection of animals that can be regarded as game, they afford great promise for the future. But this limitation is still stamped upon them, and even so enthusiastic a naturalist as Major Stevenson-Hamilton, the warden of the Transvaal Government Game Reserves, who has advocated the substitution of the camera for the rifle, appears to be of the opinion that the platform of the convention of 1900 is sufficient. It included the sparing of females and immature animals, the establishment of close seasons and game sanctuaries, the absolute protection of rare species, restrictions on the export for trading purposes of skins, horns and tusks, and the prohibition of pits, snares and game traps. Certainly the rulers of Africa are seeing to the establishment of game reserves. As for British Africa, there are two in Somaliland, two in the Sudan, two in Uganda and two in British East Africa (with separate reserves for eland, rhinoceros and hippopotamus), two in Nyasaland, three in the Transvaal, seven in Rhodesia, several in Natal and in Cape Colony, and at least four in Nigeria. These are now administered by competent officials, who in addition are usually the executive officers of the game laws outside the reserved territory. Here again, however, the preservation of game animals and of other animals of economic value, and of a few named species is the fundamental idea. In 1909 I had the honor of being a member of a deputation to the Secretary of State for the Colonies, arranged by the Society for the Preservation of the Wild Fauna of the Empire, one of the most active and successful bodies engaged in arousing public opinion on the subject. Among the questions on which we were approaching Lord Crewe was that of changes in the locality of reserves. Sometimes it had happened that for the convenience of settlers or because of railway extension, or for some other reason, proposals were made to open or clear the whole or part of a reserve. When I suggested that the substitution of one piece of ground for another, even of equivalent area, might be satisfactory from the point of view of the preservation of large animals, but was not satisfactory from the zoological point of view, that in fact pieces of primeval land and primeval forest contained many small animals of different kinds which would be exterminated once and for all when the land was brought under cultivation, the point was obviously new not only to the Colonial Secretary, who very courteously noted it, but to my colleagues.

This brings me to the general conclusion to which I wish to direct your attention and for which I hope to engage your sympathy. We may safely leave the preservation of game animals, or rare species if these are well known and interesting, and of animals of economic value, to the awakened responsibility and the practical sense of the governing powers, stimulated as these are by the enthusiasm of special societies. Game laws, reserves where game may recuperate, close seasons, occasional prohibition and the real supervision of license holders are all doing their work effectively. But there remains something else to do, something which I think should interest zoologists particularly, and on which we should lead opinion. There exist in all the great continents large tracts almost empty of resident population, which still contain vegetation almost undisturbed by the ravages of man, and which still harbor a multitude of small animals, and could afford space for the larger and better-known animals. These tracts have not yet been brought under cultivation, and are rarely traversed except by the sportsman, the explorer and the prospector. On these there should be established, in all the characteristic faunistic areas, reservations which should not be merely temporary recuperating grounds for harassed game, but absolute sanctuaries. Under no condition should they be open to the sportsman. No gun should be fired, no animal slaughtered or captured save by the direct authority of the wardens of the sanctuaries, and for the direct advantage of the denizens of the sanctuaries, for the removal of noxious individuals, the controlling of species that were increasing beyond reason, the extirpation of diseased or unhealthy animals. The obvious examples are not the game reserves of the old world, but the national parks of the new world and of Australasia. In the United States, for instance, there are now the Yellowstone National Park with over two million acres, the Yosemite in California with nearly a million acres, the Grand Cañon Game Preserve with two million acres, the Mount Olympus National Monument in Washington with over half a million acres and the Superior Game and Forest Preserve with nearly a million acres, as well as a number of smaller reserves for special purposes, and a chain of coastal areas all round the shores for the preservation of birds. In Canada, in Alberta, there are the Rocky Mouutains Park, the Yoho Park, Glacier Park and Jasper Park, together extending to over nine million acres, whilst in British Columbia there are smaller sanctuaries. These, so far as laws can make them, are inalienable and inviolable sanctuaries for wild animals. We ought to have similar sanctuaries in every country of the world, national parks secured for all time against all the changes and chances of the nations by international agreement. In the older and more settled countries the areas selected unfortunately must be determined by various considerations, of which faunistic value can not be the most important. But certainly in Africa, and in large parts of Asia, it would still be possible that they should be selected in the first place for their faunistic value. The scheme for them should be drawn up by an international commission of experts in the geographical distribution of animals, and the winter and summer haunts of migratory birds should be taken into consideration. It is for zoologists to lead the way, by laying down what is required to preserve for all time the most representative and most complete series of surviving species without any reference to the extrinsic value of the animals. And it then will be the duty of the nations, jointly and severally, to arrange that the requirements laid down by the experts shall be complied with.

And now I come to the last side of my subject, that of zoological gardens, with which I have been specially connected in the last ten years. My friend M. Gustave Loisel, in his recently issued monumental "Histoire des Ménageries" has shown that in the oldest civilizations of which we have record, thousands of years before the Christian era, wild animals were kept in captivity. He is inclined to trace the origin of the custom to a kind of totemism. Amongst the ancient Egyptians, for instance, besides the bull and the serpent, baboons, hippopotami, cats, lions, wolves, ichneumons, shrews, wild goats and wild sheep, and of lower animals, crocodiles, various fishes and beetles were held sacred in different towns. These animals were protected, and even the involuntary killing of any of them was punished by the death of the slayer, but besides this general protection, the priests selected individuals which they recognized by infallible signs as being the divine animals, and tamed, guarded and fed in the sacred buildings, whilst the revenues derived from certain tracts of land were set apart for their support. The Egyptians were also famous hunters and kept and tamed various wild animals, including cheetahs, striped hyenas, leopards, and even lions which they used in stalking their prey. The tame lions were sometimes clipped, as in ancient

Assyria, and used both in the chase and in war. The rich Egyptians of Memphis had large parks in which they kept not only the domestic animals we now know, but troops of gazelles, antelopes and cranes which were certainly tame and were herded by keepers with wands. So also in China at least fifteen centuries before our era, wild animals were captured in the far north by the orders of the emperor and were kept in the royal parks. A few centuries later the Emperor Wen-Wang established a zoological collection between Pekin and Nankin, his design being partly educational, as it was called the Park of Intelligence. In the valley of the Euphrates, centuries before the time of Moses, there were lists of sacred animals, and records of the keeping in captivity of apes, elephants, rhinoceroses, camels and dromedaries, gazelles and antelopes, and it may well be that the legend of the Garden of Eden is a memory of the royal menagerie of some ancient king. The Greeks, whose richest men had none of the wealth of the Egyptians or of the princes of the East, do not appear to have kept many wild animals, but the magnates of imperial Rome captured large numbers of leopards, lions, bears, elephants, antelopes, giraffes, camels, rhinoceroses and hippopotami, and ostriches and crocodiles, and kept them in captivity, partly for use in the arena, and partly as a display of the pomp and power of wealth. In later times royal persons and territorial nobles frequently kept menageries of wild animals, aviaries and aquaria, but all of these have long since vanished.

Thus, although the taste for keeping wild animals in captivity dates from the remotest antiquity, all the modern collections are of comparatively recent origin, the oldest being the Imperial Menagerie of the palace of Schönbrunn, Vienna, which was founded about 1752, whilst some of the most important are only a few years old. These existing collections are of two kinds. A few are the private property of wealthy landowners, and their public importance is due partly to the opportunity they have afforded for experiments in acclimatization on an extensive scale, and still more to the refuge they have given to the relics of decaying species. The European bison is one of the best-known cases of such preservation, but a still more extraordinary instance is that of Pére David's deer, a curious and isolated type which was known only in captivity in the imperial parks of China. The last examples in China were killed in the Boxer war, and the species would be absolutely extinct but for the small herd maintained by the Duke of Bedford at Woburn Abbey. In 1909 this herd consisted of only twenty-eight individuals; it now numbers sixty-seven. The second and best-known types of collections of living animals are in the public zoological gardens and parks maintained by societies, private companies, states and municipalities. There are now more than a hundred of these in existence, of which twenty-eight are in the United States, twenty in the German Empire, five in England, one in Ireland, and none in Scotland. But perhaps I may be allowed to say how much I hope that the efforts of the Zoological Society of Scotland will be successful, and that before many months are over there will be a zoological park in the capital of Scotland. There is no reason of situation or of climate which can be urged against it. The smoke and fog of London are much more baleful to animals than the east winds of Edinburgh. The gardens of north Germany and the excellent institution at Copenhagen have to endure winters much more severe than those of lowland Scotland, whilst the arctic winter and tropical summer of New York form a peculiarly unfortunate combination, and none the less the Bronx Park at New York is one of the most delightful menageries in existence. The Zoological Society of Scotland will have the great advantage of beginning where other institutions have left off; it will be able to profit by the experience and avoid the mistakes of others. The Zoological Society of London would welcome the establishment of a menagerie in Scotland, for scientific and practical reasons. As I am speaking in Scotland, I may mention two of the practical reasons. The first is that in Great Britain we labor under a serious disadvantage as compared with Germany with regard to the importation of rare animals. When a dealer in the tropics has rare animals to dispose of, he must send them to the best market, for dealing in wild animals is a risky branch of commerce. If he send them to this country, there are very few possible buyers, and it often happens that he is unable to find a purchaser. If he send them to Germany, one or other of the twenty gardens is almost certain to absorb them, and failing Germany, Belgium and Holland are near at hand. Were there twenty prosperous zoological gardens in Great Britain, they could be better stocked, at cheaper rates, than those we have now. The second practical reason is that it is a great advantage to menageries to have easy opportunities of lending and exchanging animals; for it often happens that as a result of successful breeding or of gifts on the one hand, or of deaths on the other, a particular institution is overstocked with one species or deficient in another.

One of the ideas strongly in the minds of those who founded the earlier of modern zoological gardens was the introduction and acclimatization of exotic animals that might have an economic value. It is curious how completely this idea has been abandoned and how infertile it has proved. The living world would seem to offer an almost unlimited range of creatures which might be turned to the profit of man and as domesticated animals supply some of his wants. And yet I do not know of any important addition to domesticated animals since the remotest antiquity. A few birds for the coverts, fancy water-fowl for ponds and lakes, and brightly plumaged birds for cages or for aviaries have been introduced, chiefly through zoological societies, but we must seek other reasons for their existence than these exiguous gains.

Menageries are useful in the first place as educational institutions, in the widest sense of the word. Every new generation should have an opportunity of seeing the wonder and variety of animated nature, and of learning something that they can not acquire from books or pictures or lectures about the chief types of wild animals. For that reason zoological gardens should be associated in some form with elementary and secondary education. We in London admit the children from elementary schools on five mornings in the week at the nominal charge of a penny for each child, and in cooperation with the educational committee of the London County Council, we conduct courses of lectures and demonstrations for the teachers who will afterwards bring their children to visit the gardens.

Menageries provide one of the best schools for students of art, for nowhere else than amongst living animals are to be found such strange fantasies of color, such play of light on contour and surface, such intricate and beautiful harmonies of function and structure. To encourage art the London Society allows students of recognized schools of drawing and painting, modelling and designing, to use the gardens at nominal rates.

Menageries provide a rich material for the anatomist, histologist, physiologist, parasitologist and pathologist. It is surprising to note how many of the animals used by Lamarck and Cuvier, Johannes Müller and Wiedersheim, Owen and Huxley were obtained from zoological gardens. At all the more important gardens increasing use is being made of the material for the older purposes of anatomical research and for the newer purposes of pathology and physiology.

There remains the fundamental reason for the existence of menageries, that they are collections of living animals and therefore an essential material for the study of zoology. Systematic zoology, comparative anatomy, and even morphology, the latter the most fascinating of all the attempts of the human intellect to recreate nature within the categories of the human mind, have their reason and their justification in the existence of living animals under conditions in which we can observe them. And this leads me to a remark which ought to be a truism but which, unfortunately, is still far from being a truism. The essential difference between a zoological museum and a menagerie is that in the latter the animals are alive. The former takes its value from its completeness, from the number of rare species of which it has examples, and from the extent to which its collections are properly classified and arranged. The value of a menagerie is not its zoological completeness, not the number of rare animals that at any moment it may contain, not even the extent to which it is duly labeled and systematically arranged, but the success with which it displays its inhabitants as living creatures under conditions in which they can exercise at least some of their vital activities.

The old ideal of a long series of dens or cages in which representatives of kindred species could mope opposite their labels is surely but slowly disappearing. It is a museum arrangement, and not an arrangement for living animals. The old ideal by which the energy and the funds of a menagerie were devoted in the first place to obtaining species "new to the collection" or "new to science" is surely but slowly disappearing. It is the instinct of a collector, the craving of a systematist, but is misplaced in those who have the charge of living animals. Certainly we like to have many species, to have rare species, and even to have new species represented in our menageries. But what we are learning to like most of all is to have the examples of the species we possess, whether these be new or old, housed in such a way that they can live long, and live happily, and live under conditions in which their natural habits, instincts, movements and routine of life can be studied by the naturalist and enjoyed by the lover of animals.

Slowly the new conditions are creeping in, most slowly in the older institutions hampered by lack of space, cumbered with old and costly buildings, oppressed by the habits of long years and the traditions established by men who none the less are justly famous in the history of zoological science. Space, open air, scrupulous attention to hygiene and diet, the provision of some attempt at natural environment are receiving attention that they have never received before. You will see the signs of the change in Washington and New York, in London and Berlin, in Antwerp and Rotterdam, and in all the gardens of Germany. It was begun simultaneously, or at least independently, in many places and under the inspiration of many men. It is, I think, part of a general process in which civilized man is replacing the old hard curiosity about nature by an attempt at sympathetic comprehension. We no longer think of ourselves as alien from the rest of nature, using our lordship over it for our own advantage; we recognize ourselves as part of nature, and by acknowledging our kinship we are on the surest road to an intelligent mastery. But I must mention one name, that of Carl Hagenbeck, of Hamburg, to be held in high honor by all zoologists and naturalists, although he was not the pioneer, for the open-air treatment and rational display of wild animals in captivity were being begun in many parts of the world while the Thier-Park at Stellingen was still a suburban waste. He has brought a reckless enthusiasm, a vast practical knowledge and a sympathetic imagination to bear on the treatment of living animals, and it would be equally ungenerous and foolish to fail to recognize the widespread and beneficent influence of his example.

However we improve the older menageries and however numerous and well-arranged the new menageries may be, they must always fall short of the conditions of nature, and here I find another reason for the making of zoological sanctuaries throughout the world. If these be devised for the preservation of animals, not merely for the recuperation of game, if they be kept sacred from gun or rifle, they will become the real zoological gardens of the future, in which our children and our children's children will have the opportunity of studying wild animals under natural conditions. I myself have so great a belief in the capacity of wild animals for learning to have confidence in man, or rather for losing the fear of him that they have been forced to acquire, that I think that man, innocent of the intent to kill, will be able to penetrate fearlessly into the sanctuaries, with camera and notebook and field-glass. In any event all that the guardians of the future will have to do will be to reverse the conditions of our existing menageries and to provide secure enclosures for the visitors instead of for the animals.

I must end as I began this address by pleading the urgency of the questions I have been submitting to you as an excuse for diverting your attention to a branch of zoology which is alien from the ordinary avocations of most zoologists, but which none the less is entitled to their fullest support. Again let me say to you that I do not wish to appeal to sentiment; I am of the old school, and believing that animals are subject and inferior to man, I set no limits to human usufruct of the animal kingdom. But we are zoologists here, and zoology is the science of the living thing. We must use all avenues to knowledge of life, studying the range of form in systematic museums, form itself in laboratories, and the living animal in sanctuaries and menageries. And we must keep all avenues to knowledge open for our successors, as we can not guess what questions they may have to put to nature.

P. Chalmers Mitchell

THE EIGHTH INTERNATIONAL CONGRESS OF APPLIED CHEMISTRY

A preliminary report by Dr. Bernhard Hesse, the secretary of the congress, shows that in the seven days' sessions in New York City, September 6–12, the twenty-four sections of the congress read over five hundred papers, of which about half were discussed. Over five hundred of the papers presented were in print before the congress assembled in New York, thus greatly facilitating their discussion. Every one who has had experience in getting papers into print in advance of a scientific meeting will join in hearty congratulations to the officers of the congress and to its publication committee for this extraordinary feat. Six highly interesting public lectures, by well-known specialists, upon topics of present interest, added to the general attractiveness of the congress. Of the 4,500 members in various parts of the world, 2,173, coming from thirty different countries, were in attendance. The American Chemical Society, the American Institute of Chemical Engineers, the New York branch of the Society of Chemical Industry, the American branch of the Verein Deutscher Chemiker, the American Institute of Mining Engineers and the American Electrochemical Society joined forces with the congress and held joint meetings with the various sections in which they were particularly interested. Such is, in barest outline, a glance at the statistics of the congress.

Of social functions and opportunities for personal intercourse, the congress presented an "embarrassment of riches." Received in a most cordial and genial manner by President Taft on the lawn of the White House, by the secretary and board of regents of the Smithsonian Institution in the new National Museum, by the various scientific bureaus and laboratories of Washington; fêted to the limit of time and capacity in New York City, given a memorable steamer trip up the glorious Hudson, in perfect weather, and finally winding up with two extensive trips of ten and forty days respectively, through the most interesting parts of the United States—each chemist in attendance had the fullest opportunity for feeling welcome, for meeting distinguished colleagues and for seeing the best and most wonderful sights of America.

Of the notable features of the congress, the lecture of Mr. Eyde, the Nestor of the Norwegian saltpeter industry, deserves first place. To probably two thousand people, in the great hall of the Natural History Museum, New York, he told the fascinating story of fixing the nitrogen of the air to nitric acid, in the great Norwegian factories where 250,000 horsepower is harnessed and toiling for this great enterprise. A close second was the lecture on synthetic or manufactured rubber, by Dr. Perkin, of England, the importance of which product is recognized by every one. Dr. Duisberg, of Germany, who claims the honor of the invention for Germany, showed automobile tires of the new product which had given entire satisfaction, but while Germany has done much in developing the invention, the honor of originating it is recognized as belonging to England. But there are honors enough in recent chemical achievements to go all the way around, and no country represented at the congress was without its contributions to chemical successes to which it could point with pride.

Of the resolutions passed by the congress, one of international significance was the approval of the work of, and the continuance of, the commission to publish annual volumes of newly determined chemical and physical constants. The 1910 volume, just issued, is such a splendid and useful volume, that the commission was authorized to continue its preparation of the 1911 and 1912 volumes. Another resolution authorized the use until 1915 of the published atomic weights of 1912 as the standard official table for commercial purposes, thus putting an end to the confusion caused in chemical industries by the use of atomic weights revised every year. Another resolution aimed at standardizing the strength and purity of pharmaceutical products all over the world; another the establishing of better and standard methods of sampling ores, metals and fuels. Other resolutions of a more technical nature, useful to the chemical industry but hardly interesting to the general scientific public, need not be mentioned.

Speaking for ourselves, as hosts, the advantages and returns to us have been colossal. Always in danger of becoming insular, in spite of our continental proportions, we have now felt the liberalizing contact with notable men of other lands speaking other languages. We have had forced upon us the various points of view, from which other people see, not only chemical questions, but from which they regard the general problems of economics, legislation, labor, industry, commerce and the general well-being of nations and the advance of civilization. And we are enriched thereby, educated, inspired. Have we not also had the inestimable privilege of seeing, hearing, perchance of conversing with, some of the great lights of science whose names are veritable household words and whose presence among us is of itself an uplift? We now feel that we have a grasp on the best that the world can give us, that we henceforth work together with the master minds of the world towards a common goal, that we are an integral part of the great throbbing universal science-world of which we may have felt, heretofore, that we were only an outlying province or a disconnected branch.

Having spoken for ourselves, may we add, speaking for our guests, and doing them the courtesy of taking their words at par value, that they have been equally benefited. America is a name to conjure with in other parts of the world; it is the land of liberty (perhaps of too much liberty), the abode of the most energetic people on earth (perhaps of the too strenuous), the scene of the most colossal activity ever heard of in history (activity perhaps bordering on hysteria), the locus of engineering feats (sometimes with too low a factor of safety) which challenge the admiration of the rest of the world. Of this wonderful country the foreigner has heard, read and seen pictures until, if he has a spark of imagination, his enthusiastic desire to visit it is almost beyond belief. To many such it is the fond dream of a life time. But the wide Atlantic, or the broader Pacific, lies between and many think of the long sea voyage (so restful and agreeable to most of us) with rising fears. However, having made the decision to come, accepted the sacrifices involved and landed among us, having seen as much as could be crowded into the time available, and then returned to their homes, what is the resultant for these members of the congress?

From a most general point of view, without any pride of land or accomplishment, let us admit that our ever-welcome foreign visitor carries back to Europe and other foreign lands the germ of Americanism. American travelers, writers, scientists, are doing a great deal towards "Americanizing" the rest of the world, but our foreign visitors, who see us as we are (not as we pretend ourselves to be), with our human failings as well as our almost superhuman achievements, carry back a juster appreciation of the true American spirit—and its frailties make it even more attractive. The intense love of accomplishment, the generous sharing of credit with others, the brushing aside of formalities and cutting of red tape when things are to be done which should be done, the good will and fellowship towards colleagues and co-workers—these are but a few of the attributes of the American spirit which our foreign guests are quick to perceive and appreciate, and not slow to assimilate and to imitate. Shall we not believe them when they speak of these things with admiration, and tell us that these are the most valuable souvenirs they take back with them to their distant homes? And having arrived there does not the leaven still work? I hesitate to think that any of our fallings from grace (in the way, for instance, of oppressive monopolies and unfair competition) are thus disseminated through the world—I doubt that they are—but I have no manner of doubt that our observing, appreciative and discriminating visitors from abroad will become active propagandists of the distinctively American virtues which they so disingenuously admit us to possess. Careful observers of conditions in Europe, particularly of those parts of Europe most open to the impress of Americanism, see there plainly this growth of the American spirit, in politics, government, science and particularly in the general attitude of people towards each other and towards their daily life. Our visitors will return to their homes partly "Americanized," in the better, or let us say in the best, sense of that word, and let us not be so falsely modest as to deny these facts.

The next International Congress of Applied Chemistry will be held in Saint Petersburg, in 1915, at a time early enough in the year not to interfere with attendance later at our Panama Exposition in San Francisco. In fact, let us here suggest to American chemists that their program for the jubilee year

1915 should be to attend the congress, travel through Russia and Siberia and cross the Pacific to our great World Exposition, thus combining two unrivaled opportunities, the like of which will never occur again. We are the richest people on earth and the most ambitious; let us also become the best informed and the most cosmopolitan: real "citizens of the world."

J. W. Richards

Lehigh University

HENRY ADAM WEBER

Henry Adam Weber, professor in agricultural chemistry, Ohio State University, and widely known as an expert chemist, died at his home in Columbus, June 14, after a brief illness from apoplexy. He had not been well for some months and had not been actively engaged in teaching. He was 67 years old.

Professor Weber was born in Clinton Township, July 12, 1845. He studied at Otterbein University. In 1863 he went to Germany to complete his education and studied at the University of Munich. He was one of the early pupils of the eminent German chemist, Justus von Liebig.

Returning to America, he was given the degree of doctor of philosophy by Ohio State University in 1879. For several years Mr. Weber served as assistant chemist for the Ohio geological survey and then became professor of chemistry in the University of Illinois. He attracted wide attention by experiments in the manufacture of sugar from sorghum and held several patents.

In 1884 he returned to Ohio and became professor of agricultural chemistry at Ohio State University, which position he held until the time of his death, and in which he achieved much work of note in the field of agricultural and food chemistry. He held the position of chief chemist of the state dairy and food commission from 1884 to 1897.

He was a fellow in the American Association for the Advancement of Science, a member of the Chemical Society and the Ohio Academy of Science. He was the first president of the Columbus Chemical Society and continued in that office several years. Professor Weber served four years on a committee appointed by Dr. Harvey W. Wiley for the standardization of pure foods, and was the author of a course in qualitative analysis that passed through four editions.

THE DEDICATION OF THE RICE INSTITUTE

The president and trustees of the Rice Institute have arranged an academic festival from October 10 to 13 to dedicate the institution with appropriate ceremonies and to inaugurate the educational program with a series of lectures. These inaugural lectures are as follows:

* Professor Rafael Altamira y Crevea, of Madrid, Spain; late Professor of the History of Spanish Law in the University of Oviedo; Director of Elementary Education in the Spanish Ministry of Public Instruction.

* Professor Emile Borel, of Paris, France; Director of Scientific Studies at the Ecole Normale Supérieure; Editor-in-Chief of *La Revue du Mois;* Professor of the Theory of Functions at the University of Paris.

Senator Benedetto Croce, of Naples, Italy; Life Senator of the Italian Kingdom; Member of various Royal Commissions; Editor of *La Critica.*

* Professor Hugo de Vries, of Amsterdam, Holland; Director of the Hortus Botanicus and Professor of the Anatomy and Physiology of Plants in the University of Amsterdam.

* Professor Sir Henry Jones, of Glasgow, Scotland; Fellow of the British Academy; Professor of Moral Philosophy in the University of Glasgow; Hibbert Lecturer on Metaphysics at Manchester College, Oxford.

Privy Councillor Baron Dairoku Kikuchi, of Tokyo, Japan; late Japanese Minister of Education; formerly President of the University of Tokyo, and later of the University of Kyoto; recently Lecturer on Japanese Education at the University of London.

Professor John William Mackail, of London, England; former Fellow of Balliol College, and late Professor of Poetry in Oxford University.

Privy Councillor Professor Wilhelm Ostwald, of Gross-Bothen, Germany; late Professor of Chemistry in the University of Leipsic; Nobel Laureate in Chemistry, 1909.

The late Professor Henri Poincaré, of Paris, France; Member of the French Academy; Commander of the Legion of Honor; Professor of Mathematics and Astronomy at the University of Paris.

* Professor Sir William Ramsay, K.C.B., of London, England; late Professor of Chemistry at University College, London; Nobel Laureate in Chemistry, 1904; President of the Seventh International Congress of Applied Chemistry.

Professor Carl Störmer, of Christiania, Norway; Member of the Norwegian Academy of Sciences; Associate Editor of the Acta Mathematica; Professor of Pure Mathematics in the University of Christiania.

* Professor Senator Vito Volterra, of Rome, Italy; Life Senator of the Italian Kingdom; Dean of the Faculty of Science and Professor of Mathematical Physics and Celestial Mechanics in the University of Rome; recently Lecturer in the Universities of Paris and Stockholm.

Each of these gentlemen has consented to prepare three lectures for the proceedings of the opening festival and to permit the institute to publish his dissertations in a series of volumes which it is proposed to issue in commemoration of the occasion. Those lectures whose names are designated above by an asterisk will be present and read the introductory lectures of their respective courses: the lectures of those whose names are not so designated will be contributed in manuscript and placed upon the program by title.

SCIENTIFIC NOTES AND NEWS

The eighty-second annual meeting of the British Association, which opened on September 4, had a preliminary registration of 2,379 members, which is considerably larger than the average. At the opening meeting, at which the address of Professor Schäfer, already published in Science, was delivered, it was announced that Mr. J. K. Caird, of Dundee, had given £10,000 to the funds of the association.

Dr. Simon Flexner, director of the laboratories of the Rockefeller Institute, has been appointed Huxley lecturer for the current year. This lecture will be given before the Charing Cross Hospital Medical School, London, on October 31, 1912.

Professor Hugo de Vries lectured at the New York Botanical Garden on September 14.

Professor Wilhelm Ostwald, who had intended to be present at the opening of the Rice Institute and to lecture at several universities, has been obliged to cancel his American trip, owing to ill-health.

Sir William Turner, professor of anatomy at Edinburgh, and Dr. Julius von Hann, professor of meteorology at the University of Vienna, have been appointed foreign knights of the Prussian order "Pour le mérite."

Alfred H. Brooks, geologist in charge of the Alaskan division of the U. S. Geological Survey, has been appointed a member of the Alaskan Railroad Commission, and is now en route to Alaska.

Mr. V. H. Hughes, E.M., has been appointed assistant state geologist of Missouri.

Dr. Frederick J. Birchard, formerly assistant in chemistry at the Rockefeller Institute, has been appointed a research chemist in the Dairy Division of the Bureau of Animal Industry, Washington, D. C.

The Board of Scientific Directors of the Rockefeller Institute for Medical Research announce the following appointments: Michael Heidelberger, fellow in chemistry; Linda Bartels Lange, fellow in pathology; Florentin Medigreceanu, assistant resident physician.

A course of two weeks devoted to an extension course in nervous and mental diseases has been given at Fordham University School of Medicine. Among those taking part were Drs. Henry Head and Gordon Holmes, of London; Dr. Carl Jung, of Zurich; Dr. Alwyn Knauer, of Munich; Dr. N. Achucarro, of Madrid, and Dr. Colon K. Russel, of Montreal.

Professor H. Straus, Berlin, will deliver a course of lectures, October 12, 14, 15, on diseases of the stomach and kidneys, at the New York Post-Graduate Medical School, and Professor Dr. Carl von Noorden, physician in chief of the City Hospital, Frankfort, Germany, a course on pathology and treatment of diabetes, radium therapy and arteriosclerosis, October 28–31 inclusive..

The Rev. Robert Ashington Bullen, the well-known English naturalist, died on August 15, aged sixty-two years.

Mr. Clinton Thomas Bent, a distinguished British surgeon, known also for explorations in the Caucasus and elsewhere, died on August 26, aged sixty-one years.

Dr. Fritz Kötter, professor of applied mathematics at the Berlin Technological Institute, died on August 17, aged sixty-one years.

Dr. Rudolf Hörnes, professor of geology at Gratz, died on August 20, aged sixty-two years.

The fourth National Conservation Congress will be held at Indianapolis on October 1, 2, 3 and 4, under the presidency of Mr. J. B. White, of Kansas City, Mo.

The late Mr. Allan Octavian Hume, known as an ornithologist and botanist, bequeathed about £14,000 to the South London Botanical Institute, to which in 1907 he gave £10,000.

The late Professor Lombroso offered every second year in connection with the *Archiv d'Anthropologia Criminale* a prize of Fr. 500 for the best work in connection with criminal anthropology. His family have now offered to the organization committee of the Eighth International Congress of Criminal Anthropology a prize of Fr. 1,000 for the best work reported to the congress which is to be held in Budapest in the summer of 1914.

A despatch received from the American ambassador to Brazil relative to the approaching eclipse of the sun (October 10 next), which will be visible in that country states that: "The Brazilian minister of agriculture, desirous of assisting the foreign astronomical expeditions which propose to observe the eclipse, has petitioned the federal congress to appropriate $23,000 for their reception and entertainment. He has also requested that their professional instruments and private effects may be granted the privilege of free customs entry, that repairs to their instruments may be made in government workshops and that railroad passes and telegraphic franks may be given them. It is probable that the federal congress will act favorably upon the minister's petition, which has already received the endorsement of the executive."

The sundry civil bill, as passed by the last session of congress, contained an appropriation of $1,440,520 for the U. S. Geological Survey. Most of the appropriations for the survey are included in this great government supply bill, but in addition to the above amount $37,400 was appropriated in the "legislative bill," for rents, so that the total amount appropriated is $1,477,920. The principal items in the appropriations for the Geological Survey for the fiscal year ending June 30, 1913, are as follows:

Topographic surveys	$350,000
Geologic surveys	300,000
Mineral resources of Alaska	90,000
Mineral resources of the United States	75,000
Chemical and physical researches	40,000
Geological maps of the United States	110,000
Gauging streams, etc.	150,000
Surveying national forests	75,000

The bill also appropriates $145,000 for printing and binding survey reports, to be expended by the public printer.

A remarkable deposit of remains of extinct animals is now to be explored by the University of California. This is the fossil beds in the Rancho La Brea, in the outskirts of Los Angeles. There oil has oozed to the surface, and in the tar pools so formed animals have become mired and have lost their lives, and their skeletons, even to the most fragile portions, have been preserved. Madam Ida Hancock Ross, the owner of the Rancho La Brea, has given to the university the privilege of excavating these fossil beds, and work has just begun, under the direction of Dr. John Campbell Merriam, professor of paleontology and historical geology.

THE American Fisheries Society at its recent annual meeting passed the following resolutions:

WHEREAS, the Congress of the United States has passed an act to give effect to the convention between the United States, Great Britain, Russia and Japan, having for its primary object the suppression of pelagic sealing, and

WHEREAS, this measure was amended so as to establish a five-year closed season on male seals on the Pribilof Islands, contrary to the advice of the United States Bureau of Fisheries and its Advisory Board, including the best informed scientists of the country, all personally familiar with the islands and the fur seal problem, and contrary to the expressed opinion of others personally familiar with the conditions of seal life on the islands.

Therefore, be it *Resolved*, that the American Fisheries Society places on record its deep regret that congress should have acted contrary to the advice of the recognized authority in this country on such matters, and further,

Resolved, that this society recommend the early repeal of this provision which is contrary to all biological experiences and which can lead only to dissatisfaction and to the ultimate exploiting of seal fisheries by private interests and with detriment to the herd, consequent financial loss to the government, and loss of prestige to the nation.

THE following is the text of the act of congress concerning the Public Health Service:

Be it enacted by the Senate and House of Representatives of the United States of America in Congress assembled, That the Public Health and Marine-Hospital Service of the United States shall hereafter be known and designated as the Public Health Service, and all laws pertaining to the Public Health and Marine-Hospital Service of the United States shall hereafter apply to the Public Health Service, and all regulations now in force, made in accordance with law for the Public Health and Marine-Hospital Service of the United States shall apply to and remain in force as regulations of and for the Public Health Service until changed or rescinded. The Public Health Service may study and investigate the diseases of men and conditions influencing the propagation and spread thereof, including sanitation and sewage and the pollution either directly or indirectly of the navigable streams and lakes of the United States, and it may from time to time issue information in the form of publications for the use of the public.

SEC. 2. That beginning with the first day of October next after the passage of this act the salaries of the commissioned medical officers of the Public Health Service shall be at the following rates per annum: surgeon general, six thousand dollars; assistant surgeon general, four thousand dollars; senior surgeon, of which there shall be ten in number, on active duty, three thousand five hundred dollars; surgeon, three thousand dollars; passed assistant surgeon, two thousand four hundred dollars; assistant surgeon, two thousand dollars; and the said officers, excepting the surgeon general, shall receive an additional compensation of ten per centum of the annual salary as above set forth for each five years' service, but not to exceed in all forty per centum: *Provided*, That the total salary, including the longevity increase, shall not exceed the following rates: assistant surgeon general, five thousand dollars; senior surgeon, four thousand five hundred dollars; surgeon, four thousand dollars: *Provided further*, That there may be employed in the Public Health Service such help as may be provided for from time to time by congress.

DR. ROLLIN T. CHAMBERLIN, of the department of geology in the University of Chicago, recently returned from a year of special investigations in South America, where he went as a geologist of the Brazilian Iron and Steel Company to examine the recently recognized iron ore deposits in the state of Minas Geraes, famous in the past for its output of gold and diamonds but likely in the future to be best known for its unrivaled mountains of iron ore. Dr. Chamberlin's special work was to locate the most promising ore masses in the district, make geologic and topographic surveys, and estimate the quantity and value of the ore. The surveys were much hindered by the necessity of cutting trails through the tropical jungle, natives armed with the Brazilian foica or wood hook being employed for the purpose. Travel was largely by muleback. In order to get a general view of the geology of the South American continent Mr. Chamberlin, after finishing his work in Minas Geraes, traveled southward through Brazil and Uruguay to Buenos Aires and returned to the United States by way of the Straits of Magellan, Chile, Bolivia, Peru and Panama.

Professor Warren K. Moorehead, curator of the department of archeology, Phillips Academy, Andover, Mass., reports that the survey of which he had charge finished its first year in Maine September 8. There were on the expedition at various times from eight to twelve men and nearly all of the Penobscot valley was examined and mapped. A great deal of work was carried on at Passadumkeag, 40 miles above Bangor, and at Lake Alamoosook, 5 miles south of Bucksport. At Passadumkeag one undisturbed cemetery was entirely dug out and at Alamoosook two cemeteries, and at Orland a fourth was found. In these four cemeteries were 170 graves and from these about 800 stone objects were recovered. These graves contained large quantities of red ochre—not the small particles often encountered in exploration in the west and south—but quarts, or in several instances more than a peck of bright pigment. The objects found in the graves vary from one or two to nineteen in number, and comprise the true gouge, various modified forms of gouges, stone celts and hatchets (usually squared) and long tapering and fluted gouges. There were also some unknown forms, particularly at Passadumkeag, where long oval stones were found. These are perforated, and several exceed a foot in length. The absence of grooved axes, of pottery and bone and shell objects, of pipes, etc., indicates the presence of a culture different from that of the Algonkin. Save in one instance, there were no human bones discovered, and the graves are so old that the stone objects themselves have frequently begun to disintegrate. Mr. Charles C. Willoughby, twenty years ago, opened three burial places in southern Maine and met with similar conditions. Professor Putnam and Mr. Willoughby considered the graves extremely old. The name "the red paint people" has been applied to this culture, temporarily.

The National Bureau of Standards in its general investigation of structural materials is engaged, among other things, in the determination of the physical properties of concrete. At the suggestion of engineers and others, the Bureau of Standards is investigating the cause of cracking in concrete structures, where the necessity for expansion and contraction joints is questioned. For this purpose, reference marks were placed last week on some of the typical old and new concrete work in Wayne County, Michigan, also at Greenwich, Connecticut. Measurements will be taken from time to time during the summer and winter to determine the expansion or contraction in the concrete caused by temperature variations and the changes of volume which take place during the hardening of the concrete. Similar reference marks are being placed on the lock walls of the Panama Canal and various other structures.

The United States has held first place among the coal-producing countries of the world since 1899, when this country supplanted Great Britain. In 1911 the total world's production of coal amounted to approximately 1,302,500,000 short tons, of which the United States contributed 496,221,168 tons, or 38.1 per cent. according to the United States Geological Survey. In the 12 years from 1899 to 1911 the production of the United States has increased over 250 per cent.; from 1899 to 1911 Great Britain has increased its output about 50 per cent., from 198,146,731 to 304,521,195 tons. The United States in 1911 produced almost 500,000,000 tons, or 63 per cent. more than Great Britain in 1911; Germany's production of coal and lignite in 1899 was 93,640,500 short tons; in 1911 it was 258,223,763 tons, an increase of over 175 per cent. The combined production of Great Britain and Germany in 1911 was 562,744,958 short tons, which exceeded the output of the United States by only 66,500,000 tons, or 13.2 per cent. These three countries, United States, Great Britain and Germany, produce more than 80 per cent. of the world's total supply of coal.

Secretary Wilson, of the U. S. Department of Agriculture, has decided to establish an experiment station on the Manti National Forest near Ephraim, Utah, for the study of grazing and water protection problems. In fact bids for the construction of the necessary buildings have been received and it is expected to have the station in working order before winter. Already the gathering of observations on the relations of erosion and run-off to the forest cover have begun. The Manti National Forest was chosen as the site for this experiment station because it offers exceptionally good opportunities for investigating problems of practical value in connection with regulated grazing. Ephraim and other towns in its neighborhood have suffered severely from floods following violent rainstorms in the mountains, and it has already been proved conclusively that the overgrazed condition of areas on which the natural vegetative cover has been seriously altered is responsible for the formation of torrents and the rapid discharge of débris-laden floodwaters. In a recent destructive storm the water ran clear from a part of the watershed which was within the National Forest, and in good condition as a result of well-regulated grazing, while from other areas it swept down sand and boulders. One of the objects of the study will be to learn how the maximum of grazing use of natural forest land can be obtained without injury to forest reproduction and stream flow. The national forests provide range during a part or all of the year for a considerable part of the stock produced in the western states. Approximately one and one half million head of cattle and horses and seven and one half million head of sheep and goats occupy the forest lands each year. These figures do not include nearly three hundred thousand calves and over four million lambs and kids for which permits are not required. The experts of the department believe that when the ranges which were denuded by many years of improper use are restored to a normal condition of productivity it will be possible to provide feed for a much larger number of stock without injury to forest growths or watersheds, and both the stockgrower and the consumer of meat products will thus be benefited. Consequently every effort is being made to determine practicable means of regenerating depleted ranges. All of the studies which are about to be initiated have this point in view.

UNIVERSITY AND EDUCATIONAL NEWS

HARVARD UNIVERSITY and Middlebury College will each receive ultimately half of $125,000, left by Daniel A. Kimball, of Stockbridge.

THE heirs of Michael Cudahy have given $10,000 toward the endowment fund of Newman Hall, at the University of California, and $1,000 each has been given by four other donors. The Newman Club is an organization of the Roman Catholic students of the university. Through the generosity of Archbishop Patrick W. Riordan, of San Francisco, who contributed $40,000 (from his "jubilee fund"), and through the aid of other friends, the club occupies Newman Hall, an admirably appointed building, which contains meeting rooms, a chapel, a library, bowling alleys, social rooms, a kitchen, etc., and which serves as a center for the social and religious life of the Catholic students. Its privileges and hospitalities are open also to the other students of the university.

DR. DON R. JOSEPH, formerly associate in physiology and pharmacology at the Rockefeller Institute, has been appointed associate professor of physiology at Bryn Mawr College.

THE following new appointments have been made at Toledo University: Oscar William Irvin, B.S. (Kentucky), professor of mechanics and physics; Rudolf Pintner, M.A. (Edinburgh), Ph.D. (Leipzig), professor of psychology and education.

THE following appointments have been made to the staff of Macdonald College, Ste. Anne de Bellevue, Quebec: Wilfrid Sadler, M.D.D., of the Midland Institute, Kingston, Derbyshire, England, assistant in bacteriology; D. W. Hamilton, Ph.D., of the New Brunswick Normal School, assistant in physics; W. M. Aikenhead, B.S.A., assistant in horticulture; Alex. R. Ness, B.S.A., assistant in animal husbandry. Professor W. Saxby Blair has resigned the chair of horticulture and accepted the position of superintendent of the Kentville, Nova Scotia, Experimental Fruit Farm and dominion maritime horticulturist. The following graduates have been appointed district demonstrators, local representatives of the college, whose function is to promote interest in scientific agriculture and to advise farmers on scientific questions: G. W. Wood, L. C. Raymond, A. A. Campbell, L. V. Parent, R. Newton.

DISCUSSION AND CORRESPONDENCE

A NEW MATHEMATICAL PRIZE

Alfred Ackermann-Teubner has founded a new mathematical prize by establishing a capital of 20,000 Marks at the University of Leipzig. For the present a prize of 1,000 Marks shall be given every other year, and the surplus interest shall be added to the capital until this amounts to 60,000 Marks. After the capital has reached 60,000 Marks all the interest, less expenses, shall be used for an annual prize, which shall be given for published work in the domain of the great German mathematical Encyclopedia.

The donor of the capital for the prize reserves the right to bestow it in 1914, without any restrictions; but after this date the prize is to be awarded, in order, for work in the following subjects: (1) History, philosophy, teaching and education; (2) mathematics, especially along the lines of arithmetic and algebra; (3) mechanics; (4) mathematical physics; (5) mathematics, especially along the line of analysis; (6) astronomy, theory of probability and theory of errors; (7) mathematics, especially along the line of geometry; (8) applied mathematics not provided for in what precedes, especially geodesy and geophysics.

Those who have received the Nobel prize shall not be considered in connection with the awarding of this prize and preference is to be given to German mathematicians, but the prize shall not be restricted to the scholars of this nationality. As long as the prize is awarded every second year, papers or monographs which have appeared during the preceding sixteen years may be considered, but only those which have been published no longer than eight years can be considered when it is awarded annually.

The prize is to be awarded for work which exhibits a prominent advance along scientific or pedagogic lines, and the limits of the subject matters to be considered shall, in general, be those of the German encyclopedia. If new penetrating mathematical theories should arise, work along these lines may also be considered. Alfred Ackermann-Teubner is at present the senior member of the great publishing firm of B. G. Teubner, of Leipzig, Germany, and has for many years taken an active part in various mathematical activities. The capital for the prize mentioned above is a consequence of the friendly relations between the donor and various prominent mathematicians.

It is probably fortunate that these prizes are to be given for work already published and not for competing memoirs relating to subjects proposed by some committee. Many of the leading mathematicians do not enter into the race of preparing competing memoirs, and it seems likely that more good will be done if mathematicians feel free to pursue those lines in which they can work most successfully. The subject of mathematics has become so broad that real progress calls for forward movements in many fields. All the various helpful interrelations can not be foreseen by a few men.

G. A. Miller

SCIENTIFIC BOOKS

Monographs on Biochemistry. The Chemical Constitution of the Proteins. Part I. Analysis. By R. A. H. Plimmer, D.Sc. Second edition. London and New York, Longmans, Green and Co. Pp. x + 188. 1912. 5 s. 6 d. net.

Although the knowledge concerning the chemical constitution of the proteins gained since the appearance of the first edition of this monograph is relatively small, the amount of information contained in this second edition is much greater than that furnished in the first. The author now gives us a more detailed account of the methods of hydrolysis of the proteins and the estimation of the amino-acids which result thereby. The chemical constitution of their constituent amino acids is extensively discussed and the methods by which each of these amino acids has been synthesized is described. The differentiation of the proteins by means of the proportion of the various types of nitrogen which they yield on hydrolysis is given in detail, as well as the recent methods for estimating amino nitrogen and also the nitrogen belonging to the different groups of amino acids.

The book contains the first practically complete compilation yet published of analyses thus far made of the products of hydrolysis of all the various individual proteins, a feature which will be appreciated by those working in this field of protein chemistry. In commenting on these analyses the author very properly emphasizes the fact that the percentages reported are in almost all cases minimal, and that none of the analyses represents the true amino acid make-up of the protein; a fact too often overlooked by those who have previously attempted to compile such analyses, which simply reveal gross differences between proteins of different origin.

Plimmer's monograph, like the others of this series, contains a very full bibliography; but, unfortunately, references in the text are not made in such a way as to readily show the papers which are authority for the statements made. This defect is especially apparent in connection with the tables of analyses of the proteins. Those who wish to quickly and pleasantly inform themselves of what is known of the chemical constitution of the proteins, and of the methods by which this has been learned, will find this monograph exceedingly satisfactory. As an experienced teacher of physiological chemistry recently wrote the reviewer, "It strikes me as a remarkably useful book; and it has more human touches than most reviews of this type."

Thomas B. Osborne

Physiologisches Praktikum für Mediziner. By Max Verworn. Second edition. Jena, Gustav Fischer. 1912. Pp. xii + 262; 141 illustrations.

It is a curious fact that Germany, the country in which the science of physiology has undergone its greatest development, has been backward in providing laboratory instruction in that science. And now that it is being provided it is to be regretted that it is on a lower pedagogic and scientific plane than in the English and especially the American universities. The book before us is a second edition from Bonn of a work, the first edition of which was issued from Göttingen five years ago. It is a combination of the chemical and the physical, about one fourth of the text being devoted to the former. There is an average of one illustration for less than two pages of text. Each main topic is introduced by a brief, concise and usually excellent summary of its physiology, and this is followed by an elaborate account of the procedures to be pursued in performing a series of selected experiments. Most of the experiments are well known to university teachers of the subject; but some are new, and a perusal of the book will prove suggestive. Many experiments which are frequently performed by students in American universities are wanting, and the only mammals employed, besides man, are the rabbit, the guinea-pig and the white rat. But the most striking feature of the book is the elaborateness of the directions for laboratory work, something with which we in America are not familiar. The student is never left to determine a procedure for himself, but is told exactly how to do the thing desired. He must, for example, hold his scalpel thus and so, the verbal directions being supplemented by a nearly life-sized picture of a hand holding the instrument; and he must make "not little, shallow, short, hurried cuts with the point of the knife, but long, firm, quiet, deep incisions with its blade." In order to tell how to make a frog's muscle-nerve preparation two pages of text are required and two additional pages of life-sized illustrations. Eight pages, including illustrations, are employed in describing the customary method of measuring the blood pressure in a mammal with the simple action of the vagus nerve on the blood pressure, the simple action of atropin on the heart, and final asphyxia. One can not examine the book without recalling Mr. Abraham Flexner's discussion of physiological instruction in Germany in his valuable report to the Carnegie Foundation on medical education in Europe. He says:

> The practical course in Germany is a thing by itself, aud is still unsatisfactorily carried on. . . . Consisting as it does of certain exercises specified and minutely described in a syllabus, the practical course tends to be an isolated series of experiments mechanically executed rather than a stimulating and successful application of scientific method to physiological problems. . . . If, then, physiology is to be taught as an experimental science, as a science of function, the student must be allowed to run risks, to calculate, to observe, to verify, to conclude. Eliminate risk and the experiment becomes a mechanical toy: it may amuse, it does not discipline.

Frederic S. Lee
Columbia University

Short Course in Electrical Testing. By Morecroft and Hehre. New York, D. Van Nostrand Company. 1911. Pp. 154. Price, $1.50 net.

This book is designed primarily for the use of students of other branches of engineering than electrical engineering. As such students are usually none too well versed in the theory of electrical engineering, due to the short time available for the study of this subject, the authors have included with the description of the experiments a brief statement of the more important principles involved. This feature should appeal to any teacher giving laboratory instruction in electrical engineering to students of another department.

The direct current experiments described deal with the measurements of the resistance of wires, of lamps and of the dynamos; the characteristics of the shunt and of the compound generator; the characteristics of the shunt and of the series motor, and the parallel operation of shunt generators and of compound generators. The alternating current experiments deal with determination of wave shape; phase displacement and power; the effect of inductance, capacity and frequency; the regulation of an alternator; transformer losses; characteristics of the induction and synchronous motors, and of the rotary converter; the parallel operation of alternators, and currents, voltages and power in three-phase circuits.

At the end of each experiment is given a number of questions concerning the principles involved and the reasons for the behavior of the various types of machines. It is to be regretted that the authors have not included in these queries more questions designed to bring out the bearing of the various characteristics upon the commercial application of the machines. Particularly for non-electrical students is it desirable, both for its inherent value and to keep the interest of the students, to bring out repeatedly the uses of the various types of machines and the features limiting their application. In some of the questions the premises are only partially stated. For example, on page 65, is the following: "Explain . . . why a series motor of the same horsepower rating as a shunt motor exerts a greater full load torque." In this connection, it may also be noted that nothing is said as to the difference in the methods of rating shunt and series motors. In fact, the question of rating and temperatures seems to be omitted entirely from the book.

In the alternating current section there are certain features which are not altogether desirable. In the first place the clockwise system of vector notation is employed. Again, the terms "impedance" and "reactance" seem to be avoided, although frequent mention is made of "conservative" and "dissipative" reactions, inductance and capacity reactions, etc. It is also to be regretted that the authors have given no index to the book.

The experiments selected and the directions given are in the main entirely satisfactory. On the whole the book should prove very useful for the purpose for which it is primarily intended, *i. e.*, a laboratory manual for non-electrical students.

Harold Pender
Massachusetts Institute of Technology

SCIENTIFIC JOURNALS AND ARTICLES

The July number (volume 13, number 3) of the *Transactions of the American Mathematical Society* contains the following papers:

J. B. Shaw: "Quaternion developments with applications."

H. S. Vandiver: "Theory of finite algebras."

Dunham Jackson: "On the degree of convergence of the development of a continuous function according to Legendre's polynomials."

Louis Ingold: "Functional differential geometry."

E. B. Van Vleck: "On the extension of a theorem of Poincaré for difference equations."

E. B. Van Vleck: "One-parameter projective groups and the classification of collineations."

J. E. Rowe: "Bicombinants of the rational plane quartic and combinants of the rational plane quintic."

The closing (July) number of volume 18 of the *Bulletin of the American Mathematical Society* contains: Report of the April meeting of the Society, by F. N. Cole; "Proof of a theorem due to Picard," by W. R. Longley; Review of Chwolson's Traité de Physique, by E. B. Wilson; "Arithmétique Générale," by E. Dumont and N. J. Lennes; Shorter Notices: Muir's Determinants, by G. A. Miller; Cohen's Lie Theory of One-Parameter Groups, by E. J. Wilczynski; Müller's Abriss der Algebra der Logik, by L. I. Neikirk; Andoyer's Cours d'Astronomie, by Kurt Laves; "Notes"; "New Publications"; List of papers read before the society and subsequently published; Index of Volume 18.

NOTES ON ENTOMOLOGY

Some years ago Dr. Y. Sjöstedt made a collecting trip to the high mountains of East Africa. The results of nearly a year's collecting in that region were gradually published, and now have all been brought together in three volumes.[1] Dr. Sjöstedt collected over 50,000 specimens of insects, belonging to about 3,500 species, of which over 1,200 were new species. Many new genera and several new families have been erected upon this material, one of the richest insect collections ever brought from Africa.

[1] "Wissenschaftliche Ergebnisse der Schwedischen Zoologischen Expedition nach dem Kilimandjaro, dem Meru, und dem umgebenden Massaisteppen Deutsch-Ostafrikas, 1905–1906, unter Leitung von Professor Dr. Yngve Sjöstedt," Stockholm, 1911, 4to.

A new entomological journal is the *Entomologische Mitteilungen* issued by the Deutsche Entomologische Museum, under the direction of Drs. S. Schenkling and C. Schaufuss. It is to be a monthly, and will contain papers on all orders of insects, but doubtless a majority will be on beetles. The first number contains a short history of the Deutsche Entomologische Museum, the only purely entomological museum in the world. With this new publication the museum abandons its previous quarto journal.

One of the results of the Belgian exploitation of the Congo was a Congo Museum, located near Brussels. This institution has now begun the issuance of a journal, *Revue Zoologique Africaine,* edited by the curator of the museum, Dr. H. Schouteden. It is to be issued irregularly; two fascicles have appeared, and are largely occupied with entomological articles treating all orders of insects.

Dr. E. M. Walker, who for some years has been studying the dragonflies of the genus *Æshna,* has now published his results.[2] It is a most painstaking and excellent work. There is a considerable amount of biologic information about these insects in the early part of the article, as well as figures of the characteristic parts of the nymphs. The author recognizes and gives complete descriptions of 16 species, most of which are confined to the northern parts of the United States and Canada. Several of the plates represent the markings of the body in color.

The position of the flies of the family Phoridæ in the system of the Diptera has been a subject for discussion for many years. It has generally been considered as on the borderland between the two main divisions of the order, put sometimes on the one side, sometimes on the other. Now Dr. D. Keilin has

[2] "The North American Dragonflies of the Genus *Æshna,*" Univ. of Toronto Studies, No. 11, pp. 213, 28 plates, 1912.

made a careful study of the larvæ of three species and unhesitatingly places the family in the Cyclorhapha.[3] These three species of *Phora* he found breeding in decaying snails, and each can be recognized in the larval and pupal condition. The author also investigates the internal anatomy of the larvæ and pupæ, and the methods of emergence of the flies.

The full paper[4] in which Frederic Muir solves the *Ascodipteron* question has recently been issued; a brief preliminary note appeared a year ago. Mr. Muir kept the bats containing parasites, and obtained puparia, which after about a month disclosed the winged flies. After mating, the female attaches to the bat, breaks off her wings and legs, and by the aid of the powerful mouthparts burrows until only the tip of her abdomen remains extruded. Her body enlarges until the head is hidden within a deep anterior pit. Both new species are from the Malay region.

A recent entomological portion of "Das Tierreich" is by Dr. H. Friese on the megachilid bees of the world.[5] The author tabulates the species according to the main geographical regions. Most of the species are from Europe or North America; the tables of the European species are doubtless fairly complete, but the tables for the American forms will be greatly enlarged, as many of our species are yet undescribed. In *Osmia* Dr. Friese lists 345 species, in *Anthidium* 247 and in *Megachile* 540. The work should be of great help to any one who would undertake the careful study of our megachilid bees.

One of the largest parts of the new "Coleopterorum Catalogus" is No. 39 on the subfamily Cerambycinæ, 574 pages. It will be of the greatest use to the numerous students of this, one of the most popular families of beetles, as its author, Dr. Aurivillius, is well known as a most careful and thorough worker. In many of the larger genera the species are arranged according to the main zoological regions.

Nathan Banks

[3] "Recherches sur la morphologie larvaire des Dipteres du genre *Phora*," *Bull. Sci. France Belg.*, XLV., pp. 27–88, 1911, 4 pls.

[4] "Two New Species of *Ascodipteron*," *Bull. Mus. Comp. Zool.*, LIV. (No. 11), pp. 331–366, 3 pls., 1912.

[5] "Das Tierreich," 28 Lieferung, Apidæ I Megachilinæ, 1911, 440 pp.

SPECIAL ARTICLES

SHEEP-BREEDING EXPERIMENTS ON BEINN BHREAGH [1]

Introductory Remarks.—It is astonishing how ignorant we all are about common things. Just test the matter on yourself. Sheep are quite common; and we are all more or less familiar with their appearance, and should therefore be able to answer some questions about them. Well then—*How many front teeth has a sheep got in its upper jaw?*

You never counted them? You have not observed? Next time you come across a sheep just look and see, and you will find that she has *none at all!*—the upper gum is bare.

We are all familiar with the fact that a sheep suckles her young; and know therefore that she possesses nipples that yield milk. How many nipples has she, and where are they located?

Human beings, of course, have only two, located on the breast. Dogs and cats and other mammals that have a litter at birth have many nipples, located in pairs all along the belly. Cows have at least four, located on the belly between the hind legs. Where are the sheep's nipples placed, and how many are there?

I must confess that I was myself unable to answer these questions, until, in the year 1890, I made a personal examination of the sheep on Beinn Bhreagh.

[1] From the *Beinn Bhreagh Recorder*, Vol. X., pp. 368–386: A typewritten periodical, limited to five copies, containing records of experiments of various kinds, conducted at Dr. Bell's summer place at Beinn Bhreagh, near Baddeck, Cape Breton Island, Nova Scotia.

One copy is deposited in the Smithsonian Institution, at Washington, D. C., and the others are in the possession of private individuals, viz., Dr. A. Graham Bell and Mr. J. G. Davidson at Beinn Bhreagh, N. S., and Mr. Gilbert H. Grosvenor and Mr. David C. Fairchild, at Washington, D. C.

It then became obvious that sheep, like human beings, have only two nipples; and that they are located, as in the case of the cow, on the belly between the hind legs.

It was also found at this examination in 1890 that some sheep have four nipples instead of two. Two of these were in the usual place and of the usual size; the extra pair lay in front, upon the belly; and the nipples were extremely small and undeveloped, more nearly resembling pimples upon the skin than nipples. They were embryonic in character and yielded no milk.

At once interesting questions began to arise: Could we, by mating four-nippled ewes with four-nippled rams, and by selecting from their progeny for breeding purposes the lambs in which the extra nipples were most fully developed, gradually create a variety of sheep that would have four nipples of equal size, all yielding milk?

If we could, by selection, create a four-nippled variety of sheep, why not a six-nippled, an eight-nippled, or a multi-nippled variety?

It was also found in 1890 that the proportion of sheep having four nipples was larger among the twin-bearing than the single-bearing ewes; and this at once raised the question as to whether there was any correlation between the number of nipples and the number of lambs at a birth.

If the four-nippled variety should turn out to be twin-bearing, as a rule, would the six-nippled and eight-nippled varieties give us triplets and quadruplets; and would the multi-nippled ewes have a litter at birth?

Twins, etc., are usually smaller at birth than single lambs, even after they have become mature, probably because their mothers are unable to supply sufficient milk for two or more lambs when the ewes have only two functional mammæ.

Would a sheep supply more milk from four functional nipples than two; and if so, would she be able to care for two lambs as easily as one?

A twin-bearing stock, able to rear twins successfully, would undoubtedly be of great value in a country like Nova Scotia, where the winters are long and the cost of sheep-breeding correspondingly great. If the farmers could raise two lambs instead of one for every ewe wintered, sheep-breeding in Nova Scotia might become a profitable industry of great importance.

These considerations led to the sheep-breeding experiments upon Beinn Bhreagh. I must here express my indebtedness to Mr. J. G. Davidson, Superintendent of Beinn Bhreagh Nursery, who has, for the last ten years, had charge of the experiments under my direction.

A Four-nippled Variety of Sheep.—By pursuing the plan of selection outlined above, we succeeded in producing upon Beinn Bhreagh, in a very few years, a four-nippled variety of sheep in which the ewes had, as a normal condition, four nipples of nearly equal size, all yielding milk.

So few cases of reversion to the ordinary two-nippled type appeared among the lambs that I felt justified in bringing the matter to the attention of the National Academy of Sciences, at their meeting in Washington, D. C., April 21, 1904.[2] At the same time I presented to the National Academy of Sciences, in pamphlet form, the "Sheep Catalogue of Beinn Bhreagh, Victoria County, Nova Scotia, showing the origin of the Multi-nippled Sheep of Beinn Bhreagh, and giving all the descendants down to 1903."[3]

This four-nippled breed was not slowly evolved by the persistent mating together of sheep having extra nipples of embryonic character. *It sprang suddenly into existence;* for it was soon discovered that it was possible to pick up here and there, from the farmers of Cape Breton Island, ewes with four functional mammæ already fully developed. These were added to our flock and hastened the accomplishment of the result.

In a few years after the experiments were begun in 1890, we had so many four-nippled sheep that we were able to cut down the flock

[2] See Science, Vol. XIX., p. 767.

[3] This pamphlet may be found in many public libraries; the Library of Congress, Washington, D. C., Boston Public Library, the Library of the British Museum.

severely. We killed or sold all sheep with extra nipples in an embryonic or undeveloped form, and limited ourselves to ewes with four *functional* nipples alone.

After this point had been reached there were very few cases of reversion to the two-nippled type.

The flock speedily increased in numbers, and when, in process of time, it became largely composed of four-nippled sheep whose parents had also been four-nippled, the cases of reversion practically ceased and the breed was established.

At first it appeared that the four-nippled ewes were less fertile than ordinary sheep, for they had a smaller proportion of twins; but this turned out to be due to the fact that the process of selection had necessarily resulted at first in a flock composed mainly of young ewes, and young sheep rarely have twins. After the four-nippled ewes had grown to full maturity they were found to be as fertile in this respect as ordinary sheep, if not more so.

Most of the twins that were born on Beinn Breagh were small at birth. In the autumn, however, they were found, upon the average, to be fully equal in size and weight to the single lambs of the flock, thus demonstrating the important point that a breed of sheep had been produced *which could successfully rear twins.*

During the process of the establishment of the four-nippled breed the number of two-nippled and three-nippled lambs born in the flock gradually decreased; and five-nippled lambs took their place in increasing numbers. Then six-nippled lambs were produced, followed by the occasional appearance of seven-nippled and even eight-nippled lambs, indicating the possibility of producing breeds of sheep with a greater number of nipples than four, if desired.

Since the year 1890, the nipples of several thousand sheep on the island of Cape Breton have been examined, with the discovery that three-nippled, four-nippled and even five-nippled sheep are by no means uncommon. Six-nippled sheep, on the other hand, are extremely rare, only two having been discovered in twenty-two years which were not connected with our flock. We have never come across a seven-nippled sheep that was not descended from Beinn Bhreagh stock; and eight-nippled sheep seem to be quite unknown at present outside of Beinn Bhreagh.

The fact that four-nippled sheep, like black sheep, are to be found in every flock of considerable size, led me to push the selection in the Beinn Bhreagh flock towards the formation of a six-nippled variety, so as to secure a breed that could not be easily duplicated elsewhere.

Origin of the Six-nippled Variety of Sheep. (Ewe No. 76.)—As early as 1891 we discovered in the flock of a farmer a six-nippled ewe, with the four extra nipples very poorly developed. We purchased her and added her to our flock as "No. 76," as she was a yearling at the time.

She remained on Beinn Bhreagh for several years and gave us nine lambs in all before she died. She was mated with our best four-nippled rams, but never gave us a six-nippled lamb. The first six-nippled lamb born on Beinn Bhreagh, however (No. 610), was her direct descendant (granddaughter) without any admixture of other six-nippled blood; and the ewe, No. 610, gave us a six-nippled lamb when she was only a year old herself.

No. 76 was a white ewe, and in 1893 she was mated with a white ram, but the lamb she produced in 1894 was black. He turned out to be a ram with four nipples (No. 417), and he is largely responsible for the black blood that afterwards appeared in the Beinn Bhreagh flock.

(Ewe No. 256.)—In the course of that same year (1894) we heard of another six-nippled ewe which had been discovered in the flock of a farmer near North River, St. Ann's; but she was so wild that the people on the farm were unable to catch her for us.

As we desired to secure her before the breeding season arrived, we sent a man to the farm two or three times to assist in her capture, but all without success. She was as wild as a deer and leapt the fences and escaped to the woods.

Finally a large expedition was sent about October, 1894. The hunt occupied the greater part of a day, and at last the men succeeded in driving the ewe into a place from which there was no escape, and she was brought to Beinn Bhreagh and added to our flock as No. 256.

She turned out to be a black ewe, two years old, with six well-developed and functional nipples, well arranged in pairs. She was mated with the black ram No. 417 (the offspring of the other six-nippled ewe No. 76), so that any lamb she might have would combine the blood of the two six-nippled ewes, No. 76 and No. 256.

Of course the results of the union were eagerly looked for, but in the spring of 1895 the ewe, No. 256, escaped and lambed in the woods.

Then there was a hunt to save the possibly six-nippled lamb from the foxes that had occasionally taken toll of our flock. It took quite a large number of men, in skirmishing order, to re-capture the run-away, but the lamb turned out, after all, to be a black ewe *with only four nipples!*

Although the black six-nippled ewe (No. 256) lived for many years on Beinn Bhreagh, and gave us twelve lambs in all (including, by-the-bye, five sets of twins) we never got a six-nippled lamb from her—unless indeed her lamb No. 940 might be so considered.

This lamb (No. 940) was at first noted as a five-nippled ewe; but one of her nipples, instead of being round like the others, was greatly elongated in cross section, and had two distinct orifices. It was evidently formed by the union of two distinct nipples into one. After lambing, both of the Siamese-twin nipples were found to yield milk; and we have the ewe now recorded on our books as a six-nippled sheep.

In the autumn of 1895 the black six-nippled ewe No. 256 was again mated with the black four-nippled ram, No. 417; and in the spring of 1896 gave us black twins; one, a female with four nipples, and the other a male, No. 626, with five nipples.

This five nippled ram, No. 626, not only represented an advance in nipples over rams formerly employed; but, in addition, he combined in his own person the blood of the two six-nippled ewes, No. 76 and No. 256. He was, therefore, although black, used very extensively with the flock until white six-nippled rams appeared among his offspring, when they were substituted as the sires of the flock.

No. 810 and No. 827 (born 1898) were the first six-nippled rams employed in the flock; and six-nippled rams have been used ever since. In 1899, 25.6 per cent. of the lambs born were six-nippled, but in 1900 the percentage, for some unaccountable reason, fell to 4.4 per cent.; and the percentages in succeeding years, 1901, 1902 and 1903, were only 9.4 per cent., 9.6 per cent. and 11.1 per cent., showing a very slow rate of increase in spite of the fact that six-nippled rams had been used exclusively in the flock since the autumn of 1898.

There had been no difficulty in producing the four-nippled variety of sheep, because we had been able to obtain from surrounding farmers sheep with four nipples already fully developed to add to the flock, but in the case of the six-nippled variety we were unable to obtain this aid from the farmers.

No six-nippled sheep were to be had for love or money. We advertised for them and offered large prices. We notified butchers to examine the nipples of the sheep that came to them for slaughter, etc., but all in vain. During a period of thirteen years from the purchase of ewe No. 256, the only six-nippled sheep we were able to buy was a black ewe, No. 735, with very poorly developed extra nipples, which had been found by a butcher in Baddeck among the sheep purchased from farms in close proximity to Beinn Bhreagh, and which probably represented a leakage from our flock.

It will thus be seen that, as we were unable to obtain six-nippled blood from outside, the only way we could advance the formation of a six-nippled variety of sheep seemed to be: (1) To use six-nippled rams on the whole flock; (2) to select from the six-nippled ewes born on the place those that had the most fully developed extra nipples, discarding the others.

The second plan seemed to be impracticable on account of the small number of six-nippled ewes that made their appearance. We had perforce to keep all the six-nippled ewe lambs that appeared in order to preserve the six-nippled strain from the danger of extinction. No selection by six-nippled ewes was possible; and the bulk of the flock remained four-nippled for years in spite of the continual use of six-nippled rams.

Females More Important than Males.—We recognized the fact that we were breeding for a female peculiarity; and that in this case selection by females was probably more important than selection by males.

In the hope of increasing the number of lambs from which selection could be made we determined to enlarge our flock; and, in the autumn of 1903, we purchased several four-nippled sheep and a large number of ordinary two-nippled ewes, and used our six-nippled rams with the whole flock. This plan increased the number of lambs born in 1904 and reduced the percentage of six-nippled sheep to 4.8 per cent.

After one winter's experience it became obvious that it was inadvisable to have a large flock on account of the increased expense and the difficulty of preserving accurate records with large numbers.

In the autumn of 1904, therefore, we cut down the flock to one half; retaining only ewes having four or more functional nipples, and in the spring of 1905 the percentage of six-nippled lambs rose to 25.8 per cent.; followed by 23.6 per cent. in 1906, and 27.7 per cent. in 1907.

It was speedily realized that with a small flock continuous inbreeding was inevitable; and that it would be very advisable to introduce new blood, as the flock was undoubtedly deteriorating physically. The difficulty, however, was that no six-nippled sheep could be found outside our own flock. We searched the country far and wide, and offered fancy prices without any success.

Avoiding the Evils of Inbreeding.—In the autumn of 1906 we tried the experiment of loaning a six-nippled ram to a neighboring farmer; and we offered him $10.00 apiece for any six-nippled lambs produced, $15.00 for seven-nippled and $20.00 for eight-nippled lambs. As the result of this experiment we were able, in 1907, to purchase two six-nippled lambs.

The experiment of loaning a ram was tried again in the autumn of 1907, with the result that in 1908 we were able to purchase four six-nippled lambs, for which we paid the farmer $40.00. This excited the interest of other farmers, who now began to apply for the loan of our rams under similar conditions of payment for lambs.

This plan of loaning rams turned out to be a success; and by the autumn of 1909 it became obvious that, by pursuing this plan, we could rely upon surrounding farmers for a continual supply of new six-nippled blood without keeping a large flock ourselves.

Giving up the Four-nippled Breed.—In the autumn of 1909, therefore, we cut down our flock *to six-nippled ewes alone,* and distributed our four-nippled and five-nippled ewes, as a *bonus,* among the farmers who would use our rams.

In the spring of 1910, 50 per cent. of the lambs born on Beinn Bhreagh were six-nippled; and we were also able to purchase a number of six-nippled lambs from the farmers. Very similar results were obtained in 1911.

This spring (1912) 53.6 per cent. of our lambs were six-nippled; and the records handed in by the farmers who have used our rams indicate that we shall probably be able to purchase from fifteen to twenty six-nippled lambs this year.

The New Departure.—As it has now been demonstrated that we can rely upon a constant influx of new six-nippled blood from outside, the time has come when we may begin the selection of six-nippled sheep by females. We propose to cut down our small flock still more this year, and keep only six-nippled ewes that have all six nipples *in a functional condition.* We fully expect an increase in the percentage of six-nippled lambs born on Beinn Bhreagh next year, in spite of the fact of the large amount of alien blood in the flock. The new blood introduced has not diminished the proportion of six-nippled lambs born on the place, while it *has* resulted in increased vigor and strength in the flock as a whole. The physique has been improved to such an extent that there are now no better nor finer sheep than those to be found on Beinn Bhreagh.

A Discovery Relating to Color.—During the course of our breeding experiments a very curious fact made its appearance. It is well known that when white ewes are mated with white rams, black lambs occasionally appear among the offspring; but it has not hitherto been known that when black ewes are mated with black rams, the *offspring are always black.*

This fact was discovered by Dr. Davenport, Director of the Carnegie Institution's Station for Experimental Evolution at Long Island, N. Y., from a study of the records of the Beinn Bhreagh flock; and his conclusions have since been amply verified at Beinn Bhreagh and elsewhere.

Production of Twins.—The experience of the past has shown that twin lambs are usually the produce of old ewes; and the fact that 36 per cent. of the lambs born on Beinn Bhreagh are twins is very encouraging when we consider that they are the produce of young ewes.

We are getting twins from mothers that were only one year old, and two years old, at the time of the birth of their lambs; and 60 per cent. of the lambs born this spring from three-year-old ewes were twins.

We have only one old sheep on the place, No. 1505. She was seven years old this spring and has given us eleven lambs to date. She started out with twins when she was only a lamb herself (one year old) and has given us three sets of twins since then, besides three single lambs.

The indications are that our six-nippled stock will ultimately turn out to be twin bearers, as a rule, when they become fully mature.

In the meantime the question is: What can we do to favor the production of twins in our flock?

1. One point of importance will be to see that twin ewes are mated with twin rams.

2. Twin-bearing ewes are, on the average, much heavier than single-bearing ewes. We would therefore favor the production of twins by weeding out from the flock, while still young, ewes that are markedly under the average weight of the ewes of their age.

3. When our flock of adult ewes is large enough to permit of selection it might be well to discard ewes at the age of three years, at all events at four, if they have never given us twins; so that the bulk of our fully mature females should ultimately be composed of ewes that have produced twins when young.

These points relate to efforts to increase the *hereditary tendency* to the production of twins; but there are other points relating to *environment* which are also of importance.

Condition of Nutrition Important.—The records of weight that have been preserved at Beinn Bhreagh seem to indicate that the condition of nutrition of the mother at the time of mating has an important influence upon the conception of twins. Our records show that the twin-bearing ewes increase in weight as the mating period approaches; and that mating occurs when the ewes are in prime physical condition.

This probably explains the curious fact that the ewes, which are mated in October, have a much larger proportion of twin lambs than those which are mated later on in the breeding season; thus verifying the old saying of the farmers here that "March lambs bring twins." The pasture is at its best in October. It begins to fail in November, and by December there is very little left. Our records show that when ewes are mated in October the proportion of twins born is larger than when mating occurs in November, and that very few of the ewes mated in December have twins.

In order to favor the production of twins it is therefore necessary, or at least advisable, that the ewes should be in prime physical condition at the time of mating.

To secure this point we breed in October; and it has also been our custom for some years past to provide the ewes with extra nourishment in the form of oats, oil-cake, etc., for two or three weeks before mating.

In order to be perfectly sure that each ewe receives her proper share, individual feeding pens have been provided.

When a common trough is used the larger and stronger sheep, who need it least, get most of the food; and the smaller and weaker, who need it most, get least.

Nutrition After Mating.—Our records of weight indicate that there is a characteristic difference in the weights of twin-bearing and single-bearing ewes after mating.

The twin-bearing ewes, on the average, show a marked and even sudden dropping off in weight within two or three weeks after mating, which is not found in the case of the average single-bearing ewe.

This may be translated to mean *lowered nutrition after mating as a characteristic of the twin-bearing ewe;* and a consequent lessening of the growth of the unborn lambs, so that when the twin lambs are ultimately born they are of smaller size and weight than the average single lamb.

We sometimes find that twin lambs are very unequal in size at birth. If one is large the other is likely to be small and even deformed, indicating a struggle for existence between the unborn lambs.

This led me to suspect that many of our largest single lambs might be the survivors of twins; and a few years ago I had a young physician from Washington (Dr. Phelps) visit Beinn Bhreagh at the lambing season to see what he could discover bearing upon the point.

He was able to examine quite a number of the after-births of the sheep; and in several cases where single lambs had been produced he found indications in the after-birth of an aborted twin.

In this connection it is suggestive that our best twin-bearing ewe, No. 1505, which has given us already four sets of twins, produced this year a single lamb *weighing ten pounds at birth!* It is notorious also, that fat stock are remarkably infertile, and rarely bear twins.

All these considerations led to the belief that lessened nutrition during the period of gestation is a condition that is favorable to the preservation of unborn twins. Good nutrition at the time of mating favors the *conception* of twins; and diminished nutrition after mating favors their retention.

It is obvious, upon reflection, that ewes can not successfully bear twins, or a litter at birth, unless the lambs born are small; and lessened nutrition during the period of gestation is eminently favorable to the production of lambs that are small at birth.

These considerations led to the policy of giving the ewes extra nourishment in the form of oats, oil-cake, etc., for some time before mating; and then cutting off the extra feed soon after mating so as to throw the ewes back on the pasture alone for support.

A better, and certainly more economical plan, affecting the condition of nutrition in the same way, would be simply to mate in October when the pasture is at its best, and then give hay alone for winter feeding. The giving of oats, oil-cake, roots and other milk-promoting food might well be postponed until about the time of lambing, so as to avoid stimulating the growth of the lambs until after they are born.

In order to raise twins and triplets successfully the lambs should be small at birth, and grow large afterwards.

If we had a large number of twins from which to choose, it would be a good plan in the spring to retain only those lambs which are under the average weight at birth; and then, in the autumn, select from these those that are over the average weight. This process carried on through a series of generations would probably result in a breed of sheep producing, as a normal condition, lambs that are small at birth and which grow large afterward.

Alexander Graham Bell

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SCIENCE

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THE PHOTOCHEMISTRY OF THE FUTURE[1]

MODERN civilization is the daughter of coal, for this offers to mankind the solar energy in its most concentrated form; that is, in a form in which it has been accumulated in a long series of centuries. Modern man uses it with increasing eagerness and thoughtless prodigality for the conquest of the world and, like the mythical gold of the Rhine, coal is to-day the greatest source of energy and wealth.

The earth still holds enormous quantities of it, but coal is not inexhaustible. The problem of the future begins to interest us, and a proof of this may be seen in the fact that the subject was treated last year almost at the same time by Sir William Ramsay before the British Association for the Advancement of Science at Portsmouth and by Professor Carl Engler before the Versammlung deutscher Naturforscher und Aerzte at Karlsruhe. According to the calculations of Professor Engler Europe possesses to-day about 700 billion tons of coal and America about as much; to this must be added the coal of the unknown parts of Asia. The supply is enormous but, with increasing consumption, the mining of coal becomes more expensive on account of the greater depth to which it is necessary to go. It must therefore be remembered that in some regions the deposits of coal may become practically useless long before their exhaustion.

Is *fossil* solar energy the only one that may be used in modern life and civilization? That is the question.

[1] General lecture before the International Congress of Applied Chemistry, New York, September 11, 1912.

Sir William Ramsay has made a very careful study of the problem from the English point of view. He has considered the various sources of energy, such as the tides, the internal heat of the earth, the heat of the sun, water power, the forests and even atomic disintegration, and has come to the conclusion that none can be practically used in England on account of her special contour and climate.

Though the internal energy of the earth may produce terrible disasters through volcanic eruptions and earthquakes, it can hardly be used by man. The energy derived from the rotation of the earth (tides) can hardly be counted upon on account of the enormous quantities of water that would have to be handled. Atomic disintegration has recently been treated in a brilliant lecture by Frederick Soddy, with special reference to the enormous energy changes which are involved. If man ever succeeds in availing himself of the internal energy of the atoms, his power will surpass by far the limits assigned to it to-day. At present he is limited to the use of solar energy. Let us see, however, whether the *actual* energy may not supplant that stored up in fossil fuel. Assuming that the solar constant is three small calories a minute per square centimeter, that is, thirty large calories a minute per square meter or about 1,800 large calories an hour, we may compare this quantity of heat with that produced by the complete combustion of a kilogram of coal, which is 8,000 calories. Assuming for the tropics a day of only six hours sunshine we should have, for the day, an amount of heat equivalent to that furnished by 1.35 kg. of coal, or one kilogram in round numbers. For a square kilometer we should have a quantity of heat equivalent to that produced by the complete combustion of 1,000 tons of coal. A surface of only 10,000 square kilometers receives in a year, calculating a day of only six hours, a quantity of heat that corresponds to that produced by the burning of 3,650 million tons of coal, in round numbers three billion tons. The quantity of coal produced annually (1909) in the mines of Europe and America is calculated at about 925 million tons and, adding to this 175 million tons of lignite, we reach 1,100 million tons, or a little over one billion. Even making allowances for the absorption of heat on the part of the atmosphere and for other circumstances, we see that the solar energy that reaches a small tropical country—say of the size of Latium—is equal annually to the energy produced by the entire amount of coal mined in the world! The desert of Sahara with its six million square kilometers receives daily solar energy equivalent to six billion tons of coal!

This enormous quantity of energy that the earth receives from the sun, in comparison with which the part which has been stored up by the plants in the geological periods is almost negligible, is largely wasted. It is utilized in waterfalls (white coal) and by plants. Several times its utilization in a direct form through mirrors has been tried, and now some very promising experiments are being made in Egypt and in Peru; but this side of the problem is beyond my power to discuss and I do not propose to treat it here.

The energy produced by water power during the period of one year is equal to that produced by 70 billion tons of coal, according to the data given in Professor Engler's lecture. It is, however, very small, as might be expected, in comparison with the total energy that the sun sends to the earth every year. Let us now see what quantity of solar energy is stored by the plants: on the total surface of the various continents, which is 128 million square kilometers, there is a yearly production of 32 billion tons of vegetable matter, which, if burnt, would give the quantity of heat that corresponds to the total combustion of 18 billion tons of coal. It is not much, but even this is 17 times as much as the total present production of coal and of lignite.

I

Now let us consider the first part of our subject. Is it possible or, rather, is it conceivable that this production of organic matter may be increased in general and intensified in special places, and that the cultivation of plants may be so regulated as to make them produce abundantly such substances as can become sources of energy or be otherwise useful to civilization? I believe that this is possible. It is not proposed to replace coal by organic substances produced by plants; but it is conceivable that this organic matter may be utilized more satisfactorily than is now the case.

It has frequently been said even by persons of authority that some day the transformation of coal into bread may become not only possible but economically desirable. According to these people the ideal of the future should be to produce through synthesis from coal all substances necessary for the alimentation of man: such substances as starch, sugar and fat, also proteins and perhaps cellulose; in other words to abolish agriculture altogether and to transform the world into a garden of useless flowers. Never was a greater fallacy thought or expressed: the real problem is just the reverse of this. My friend Professor Angeli wisely called to my attention that, while the externals of life have been changed greatly by the progress of industry so as to use all our technical knowledge to increase our comfort, the quality and quantity of human alimentation have hardly changed at all; nay, a new science has come into existence (bromatology) to see that no artificial product of industry enters harmfully into our alimentation. At the time of Napoleon III. an attempt was made to substitute gelatine for meat; but it was seen very soon—and now the reason for it is known by all—that this substitute could not be sufficient to maintain life. With the relatively small reserves of coal that the past geological epoch have stored for us, it will never be desirable to produce from coal what nature generously offers us through solar energy. It is on the other hand a work worthy of praise to attempt to make plants produce the fundamental substances in larger quantity. Modern agriculture tries to do this by intensive cultivation; but it is also desirable to make the plants store up solar energy and transform it into mechanical energy.

A well-known instance of this occurred when the development of the daily press in all civilized countries made it imperative to provide wood pulp in a sufficient quantity and at low prices. Trees better adapted to the purpose were soon found and they were those which, on account of their rapid growth, could furnish the necessary cellulose sooner. For the problem we are now considering the quality of the plants is of secondary importance; they may be herbs or trees; they may grow in swamps or dry places, on the sea coast or even in the sea; the essential point is that they grow fast or that their growth may be intensified. It would be like realizing the desire of Faust:

> Und Bäume die sich täglich neu begrünen!

Mephistopheles did not consider a similar task impossible:

> Ein solcher Auftrag schreckt mich nicht,
> Mit solchen Schätzen kann ich dienen.

Should we consider the task impossible, naturally in a more limited sphere, after so many centuries of culture? I do not believe so. The above estimate of the total production of organic matter over all the solid surface of the earth, that is, of 32 billion tons a year, has for its basis the old calculation of Liebig of 2.5 tons per hectare. This may be considered even to-day the average production for all the earth. According to A. Mayer, through intensified culture the production may be increased to 10 tons per hectare, and in tropical climates it may reach 15 tons. On a square kilometer it would be 1,500 tons, corresponding to 840 tons of coal, while the solar energy received in a year by a square kilometer would be equivalent to about 300,000 tons of coal, the part of the total energy stored up by the plants being about $\frac{1}{300}$. A great deal remains to be done, but if we consider that since Liebig, largely by adopting the methods proposed by him, the production has been at least quadrupled, we may hope to do much more in the future especially if we are spurred on by necessity or even by convenience.

By increasing the concentration of carbon dioxide up to an optimum value (1 to 10 per cent. according to Kreusler) and by using catalyzers, it seems quite possible that the production of organic matter may be largely increased, making use, of course, of suitable mineral fertilizers and selecting localities adapted to the purpose owing to the climate or the condition of the soil. The harvest, dried by the sun, ought to be converted, in the most economical way, entirely into gaseous fuel, taking care during this operation to fix the ammonia (by the Mond process for instance) which should be returned to the soil as nitrogenous fertilizer together with all the mineral substances contained in the ashes. We should thus get a complete cycle for the inorganic fertilizing substances, the only waste being that common to all industrial processes. The gas so obtained should be burnt entirely on the spot in gas engines and the mechanical energy thus generated should be transmitted elsewhere or utilized in any way that seems advisable. We need not go into details. The carbon dioxide, resulting from the combustion, should not be wasted but should be returned to the fields. Thus the solar energy, obtained by rational methods of cultivation, might furnish low-priced mechanical energy, perhaps better than through the systems based on mirrors, because the plants would be the accumulators of the energy received by the earth.

But the problem of the utilization of plants in competition with coal has another and more interesting side. First of all we must remember the industries which have their basis in agriculture: the cotton and other textile industries, the starch industry, the production of alcohol and of all fats, the distillation of wood, the extraction of sugar, the production of tanning substances and other minor industries. All these industries are susceptible of improvement not only by the introduction of more advantageous technical devices in the treatment of the raw materials but also by a largely increased production of the raw materials. Let us think for an example of the progress made in the production of beet sugar.

The plants are unsurpassed masters of —or marvellous workshops for—photochemical synthesis of the fundamental substances, building up from carbon dioxide with the help of solar energy. They also produce the so-called secondary substances with the greatest ease. These latter are usually found in the plants in small quantity and are of value for special reasons. The alkaloids, glucosides, essences, camphor, rubber, coloring substances and others are of even greater interest to the public than the fundamental substances on account of their high commercial value.

In this field a battle is raging between chemical industry and nature, a battle which does honor to human genius. Up to now the products prepared from coal tar have almost always been triumphant. I do not need to remind you of the various victories; but it is possible that these may prove to have been Pyrrhic victories. A great authority on organic industries considered recently what would happen in case, for any reason, there were a rapid increase in the price of coal tar and consequently of the substances contained in it. He pointed out the inevitable effect of this on the coal tar industries. We all remember with admiration the story of the great difficulties that had to be met in the choice of the raw material for the production of indigo. It was necessary finally to use naphthalene because toluene could not be obtained in sufficient quantity. But it is not merely through a rise in the price of the raw materials that an industry may suffer; it may be brought to a standstill by a diminished interest and activity in a certain field of scientific study. It has been thoroughly established that modern industry is affiliated very intimately with pure science; the progress of one determines necessarily that of the other. Now the chemistry of benzene and its derivatives does not constitute the favorite field of research as it did during the second half of the last century. The center of interest is now to be found in the matters and problems connected with biology. Modern interest is concentrated on the study of the organic chemistry of organisms. This new direction in the field of pure science is bound to have its effect on the technical world and to mark out new paths for the industries to follow in the future.

It is a fact that lately several organic industries have been successfully developed, outside of the field of benzene and coal tar. There are flourishing industries in essences and perfumes and in some alkaloids, like coca. In these industries products, which plants produce in relatively large amounts, are converted into products of higher commercial value. For instance everybody knows that essence of violet is now made from citral contained in lemon oil. This is a line along which we ought to follow because we are certain of making progress. It is to be hoped that in the future we may obtain rubber commercially in some such way.

The question has still another side, which I believe deserves your attention; it concerns certain experiments recently made by myself together with Professor Ravenna at Bologna. It is not because we have arrived at any practical results that I refer to these experiments; but because they show definitely that we can modify to a certain extent the chemical processes that take place during the life of the plants. In a series of experiments made in an effort to determine the physiological function of the glucosides, we have succeeded in obtaining them from plants that usually do not produce them. We have been able, through suitable inoculations, to force maize to synthesize salicine. More recently, while studying the function of the alkaloids in the plants, we have succeeded in modifying the production of nicotine in the tobacco plant, so as to obtain a large increase or a decrease in the quantity of this alkaloid. This is only a beginning, but does it not seem to you that, with well-adapted systems of cultivation and timely intervention, we may succeed in causing plants to produce, in quantities much larger than the normal ones, the substances which are useful to our modern life and which we now obtain with great difficulty and low yield from coal tar? There is no danger at all of using for industrial purposes land which should be devoted to raising foodstuffs. An approximate calculation shows that on the earth there is plenty of land for both purposes, especially when the various cultivations are properly intensified and rationally adapted to the conditions of the soil and the climate. This development is the real problem of the future.

II

Technical organic industry may yet expect great help from photochemistry understood in the sense above expressed and the competition between this and the chemistry of coal tar will be a great incentive for new progress. It is also true that human genius will always tend to proceed along lines selected by itself, and there is no question but that the great development in the coal tar industry has been due in part to this splendid spirit of independence. It may be asked whether there are not other methods of production which may rival the photochemical processes of the plants. The answer will be given by the future development of photochemistry as applied to the industries and on this I have a few ideas to express. The photochemical processes have not had so far any extensive practical application outside of the field of photography. From its very beginning photography has aroused a great deal of interest; it was taken up technically and, as usually happens in similar cases, it had a rapid and brilliant success. But notwithstanding the many applications photography represents only a small part of photochemistry. So far, photochemistry has only been developed to a very slight extent, perhaps because chemists have been attracted by problems which seemed more urgent. So it happens that while thermochemistry and electrochemistry have already reached a high degree of development, photochemistry is still in its infancy. Now, however, we notice a certain awakening due to a series of studies concerning general problems and special processes, especially in the organic field, in which my friend Dr. Paul Silber and myself have taken an active part. Two recent publications, one by Plotnikow and the other by Benrath, bear witness to this. But much remains to be done both in theoretical and general photochemistry as well as in the special branches.

The photochemical reactions follow the fundamental laws of affinity, but have a special character. They are especially notable for the small temperature coefficient and are, however, comparable—a fact which is not without technical importance—to the reactions which take place at very high temperatures. According to a brilliant idea of Plotnikow, luminous radiations produce a different ionization from that due to electrolytic dissociation; the separation of an ion requires a quantity of light which is determined by the theory of Planck and Einstein. The question is therefore related to the most recent and profound speculations of mathematical physics.

For our purposes the fundamental problem from the technical point of view is how to fix the solar energy through suitable photochemical reactions. To do this it would be sufficient to be able to imitate the assimilating processes of plants. As is well known, plants transform the carbon dioxide of the atmosphere into starch, setting free oxygen. They reverse the ordinary process of combustion. It has always seemed probable that formaldehyde was the first product of the assimilation; and Curtius has at last demonstrated its presence in the leaves of the beech trees. The artificial reproduction of a similar process by means of ultraviolet rays has already been obtained by D. Berthelot. With convenient modifications could not this now actually be done on the tropical highlands? Yet the true solution consists in utilizing the radiations that pass through the entire atmosphere and reach the surface of the earth in large amounts. That a way of accomplishing this exists is proved by the plants themselves. By using suitable catalyzers, it should be possible to transform the mixture of water and carbon dioxide into oxygen and methane, or to cause other endo-energetic processes. The desert regions of the tropics, where the conditions of the soil and of the climate make it impossible to grow any ordinary crops, would be made to utilize the solar energy which they receive in so large a measure all the year, that the energy derived from them would be equal to that of billions of tons of coal.

Besides this process, which would give new value to the waste products of combustion, several others are known, which are caused by ultraviolet radiations and which might eventually take place under the influence of ordinary radiations, provided suitable sensitizers were discovered. The synthesis of ozone, of sulphur trioxide, of ammonia, of the oxides of nitrogen, as well as many other syntheses, might become the object of industrial photochemical processes.

It is conceivable that we might make photoelectrical batteries or batteries based on photochemical processes, as, for instance, in the experiments of C. Winther.

Passing to the field of organic chemistry, the reactions caused by light are so many that it should not be difficult to find some which are of practical value. The action of light is especially favorable to processes of reciprocal oxidation and reduction which give rise to or are associated with phenomena of condensation. Since the common condensation is that of the aldolic type there is much hope for the future, the aldolic condensation being the fundamental reaction of organic synthesis. Some experiments recently made by my friend Silber and by myself may serve here as an illustration. The simplest case is that of the action of light on a mixture of acetone and methyl alcohol in which

$$\begin{array}{lll} CH_3 & & CH_3 \\ | & & | \\ CO & + CH_3OH = & COH-CH_2OH \\ | & & | \\ CH_3 & & CH_3 \end{array}$$

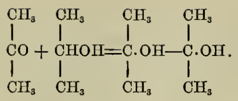
isobutylene glycol is produced. But this condensation which may be considered as a simultaneous process of oxidation and reduction, is accompanied by the reduction of the ketone to isopropyl alcohol and by the oxidation of the methyl alcohol to formaldehyde, which latter, however, does not remain as a product which can be isolated, because it reacts with the remaining methyl alcohol and is transformed into ethylene glycol:

$$\begin{array}{lllll} CH_3 & & CH_3 & & \\ | & & | & & CH_2OH \\ CO & + 2CH_3OH \rightarrow & CHOH & + & | \\ | & & | & & CH_2OH. \\ CH_3 & & CH_3 & & \end{array}$$

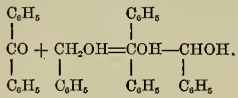
Applying the same photochemical reaction to the mixture of acetone and ethyl alcohol we have analogous products: trimethylethylene glycol; and along with this isopropyl alcohol and dimethylethylene glycol:

$$\begin{array}{llll} CH_3 & & & CH_3 \\ | & & & | \\ | & & & CHOH \\ | & & & | \\ C\cdot OH & -CH\cdot OH & \text{and} & CHOH. \\ | & | & & | \\ CH_3 & CH_3 & & CH_3 \end{array}$$

With acetone and isopropyl alcohol, as could be expected, there is formed only pinacone:

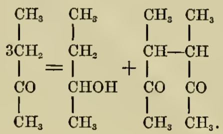


In the aromatic series benzophenone and benzyl alcohol give triphenylethylene glycol, together with other products:



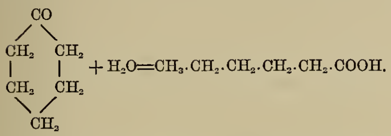
This was the first case in which this condensation has been observed; others were afterwards studied by Paternò, who replaced the benzyl alcohol by several other aromatic substances. The observations of Klinger showed that the aldehydes also underwent condensations, and this has since been confirmed by Benrath.

To get an idea of the variety of photochemical reactions we may confine ourselves to a systematic study of the ketones and alcohols. In ordinary organic chemistry the reactions often take place in some definite way; but the photochemical reactions often furnish surprises and proceed along quite different lines. From the very first experiments we knew that benzophenone did not form addition products with ethyl alcohol, but was converted into pinacone at the expense of the alcohol, which was oxidized to aldehyde. Proceeding with the study of aliphatic ketones, similar to acetone, we have this year discovered a remarkable fact. Methylethylketone condenses with itself and forms the paradiketone, reducing itself at the same time to secondary butyl alcohol:

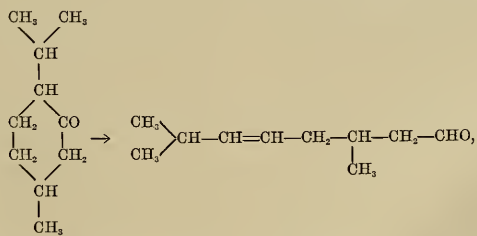


Of course the synthesis of diketones by light could not be an isolated reaction; we had previously noticed the formation of diacetyl: acetonylacetone is found, as we now know, among the products of acetone in solution in ethyl alcohol and it is also possible that the metadiketones, such as acetylacetone for instance, may be prepared photochemically. These reactions have a special importance on account of the special character of the diketones and their tendency to change in all sorts of ways. From them derivatives of benzene can be obtained as well as of pyrrazol and isoxazol, of quinoline, of furfurol, of thiophene and of pyrrol. In regard to this last change I wish to remind you that tetramethylpyrrol corresponds to the paradiketone previously referred to. If I dare to be reckless, as you may see I am at this moment, contrary to my custom, but perhaps urged thereto unconsciously by the American genius which heeds no obstacles, I may refer to the relations between the polysubstituted pyrrols with alcohol radicals and chlorophyll, and I may see in these reactions the possibility of the synthesis of this fundamental substance by means of an artificial photochemical process. Its formation in plants, like its function, is due to a photochemical process; we do not know, however, whether and in what measure light enters into all the synthetic plant reactions, from which originate the various substances which we find in plants. The research should proceed together in the two fields; phytochemistry and photochemistry will be of great help one to another. Industrially this cooperation might have a great future: the raw materials obtained from the plants might be refined through artificial photochemical processes.

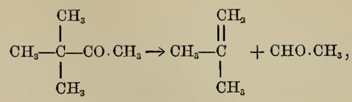
Lately we have been interested intensely by the changes that some substances of the group of the terpenes and of the camphors undergo when exposed to light, especially through hydrolytic processes. So far, indeed, our experiments have taught us that light can spoil rather than improve essences. The cycloketones, for instance, are hydrolyzed and give the corresponding fatty acids; the cycloesanone gives capronic acid and menthone gives decylic acid.



In photochemistry, however, one reaction does not exclude the other; the reactions may be reversed as some recent experiments with ultraviolet rays demonstrate; for the ultraviolet rays sometimes reverse reactions caused by less refrangible radiations. It is important to find suitable sensitizers and catalyzers. We can see what the future has in store for us from such reactions as the photolysis of the ketones, which often accompanies the hydrolysis, and by means of which we prepare isocitronellal, for instance from menthone,



or the transformation of camphor into an unsaturated cycloketone, etc. The analogous breaking down of pinacoline into butylene and acetic aldehyde,



is remarkable because it demonstrates what violent decompositions light may cause. It may be an enemy, but just on account of that it is necessary to be familiar with the weapons of the adversaries in order to be able to conquer them and to avail ourselves of their strength.

I do not believe, however, that the industries should wait any longer before taking advantage of the chemical effects produced by light. The polymerizations, the isomeric changes, the reductions and oxidations with organic and inorganic substances, and the autoxidations which light causes so easily should already find profitable applications in some industries if researches were carried out carefully with this in mind. The action of light on nitric and nitrosilicic compounds, as we know it from experience, is one that ought to be utilized profitably. Our own transformation of orthonitrobenzoic aldehyde into nitrosobenzoic acid has recently been studied by various chemists, and has been made use of by Pfeiffer, who prepared a nitrophenylisatogen from chlorodinitrostilbene. This reminds us of the not less known transformation of benzylidene orthonitroacetophenone into indigo by Engler and Dorant and makes us foresee a new field in the photochemical production of artificial colors and dyestuffs. The scope of studies on this subject ought not to be limited to preserving colors from fading, bleaching and all changes produced by light. The photochemistry of colors and dye-stuffs ought to furnish new methods of preparation and of dyeing. Very encouraging experiments have already been made with diazoic compounds and mention should be made of the recent observation of Baudisch that α-nitrosonaphthylhydroxylamine is changed on the fiber to azoxynaphthalene when exposed to light. The autoxidation of leuco compounds by light is an old practise of which the ancients availed themselves for preparing purple; now the process is explained, thanks to the familiar researches of Friedländer, but it is clear that a great deal remains to be learned in this field.

Phototropic substances, which often assume very intense colors in the light, and afterwards return in the darkness to their primitive color, might be used very effectively. Such substances might well attract the attention of fashion rather than fluorescent materials which give the impression of changing colors. The dress of a lady, so prepared, would change its color according to the intensity of light. Passing from darkness to light the colors would brighten up, thus conforming automatically to the environment: the last word of fashion for the future.

Solar energy is not evenly distributed over the surface of the earth; there are privileged regions, and others that are less favored by the climate. The former ones would be the prosperous ones if we should become able to utilize the energy of the sun in the way which I have described. The tropical countries would thus be conquered by civilization, which would in this manner return to its birthplace. Even now the strongest nations rival each other in the conquest of the lands of the sun, as though unconsciously foreseeing the future.

Where vegetation is rich, photochemistry may be left to the plants and by rational cultivation, as I have already explained, solar radiation may be used for industrial purposes. In the desert regions, unadapted to any kind of cultivation, photochemistry will artificially put their solar energy to practical uses.

On the arid lands there will spring up industrial colonies without smoke and without smokestacks; forests of glass tubes will extend over the plains and glass buildings will rise everywhere; inside of these will take place the photochemical processes that hitherto have been the guarded secret of the plants, but that will have been mastered by human industry which will know how to make them bear even more abundant fruit than nature, for nature is not in a hurry and mankind is. And if in a distant future the supply of coal becomes completely exhausted, civilization will not be checked by that, for life and civilization will continue as long as the sun shines! If our black and nervous civilization, based on coal, shall be followed by a quieter civilization based on the utilization of solar energy, that will not be harmful to progress and to human happiness.

The photochemistry of the future should not however be postponed to such distant times; I believe that industry will do well in using from this very day all the energies that nature puts at its disposal. So far, human civilization has made use almost exclusively of fossil solar energy. Would it not be advantageous to make better use of radiant energy?

Giacomo Ciamician

Bologna

THE FIRST INTERNATIONAL EUGENICS CONGRESS

The First International Eugenics Congress was held at the Imperial Institute (University of London), South Kensington, July 24, to 30, 1912. It was an outgrowth of the work of the Eugenics Education Society of England. So far as the writer is informed, the latter was the first distinct organization to be formed for the definite purpose of advancing the eugenics propaganda. It was, therefore, fitting that the first call for an international conference to discuss the problems of eugenics should emanate from this body.

The congress was a great success from every point of view. Locally it evidently helped the cause a great deal, because of the demonstration which it gave of the world-wide interest which exists in regard to eugenics. With such men in personal attendance as Professor Yves Delage, M. Lucien March, Directeur de la Statistique Générale de France, M. Paul Doumer, sometime President of the Chamber of Deputies, His Excellency General von Bardeleben, President of the Verein Herold of Berlin, Professor A. C. Haddon and Professor R. C. Punnett of Cambridge, and Professor F. C. S. Schiller of Oxford, it was evident to the most casual consideration that the eugenics movement possessed that quality of "respectability" which is dearest to the British official heart. From an international point of view the congress gave the opportunity, for which the time was ripe, for a full discussion of eugenic problems as they appear in different civilizations and communities.

The administrative details connected with the preparation for the congress and the carrying of it through were worked out in a thoroughly excellent manner. The way in which the congress was managed, and the smoothness with which the machine ran, were matters of universally favorable comment among those present. The credit for this belongs in the first instance to the honorary secretary, Mrs. Sybil Gotto.

The attendance was large—much larger indeed than any one had anticipated beforehand. Up to the day before the close of the congress 836 persons had registered. Besides these there were many who attended as daily visitors. The papers presented were, taken as a whole, of excellent quality. There was an almost entire absence of the sensationalism, and hasty generalization as to the solution of fundamental social problems, which had been in greater or less degree expected by the general public. The majority of the papers fell in the field of what might be called "practical" eugenics. No attempt was made towards a technically scientific congress. Such a policy would have been obviously unwise. Eugenics is distinctly an *applied* science. Hitherto everybody except the scientist has had a chance at directing the course of human evolution. In the eugenics movement an earnest attempt is being made to show that science is the only safe guide in respect to the most fundamental of social problems. In order to make this attempt amount to anything practically it is obvious that the man of affairs, the legislator, and the administrator must not be alienated by technicalities beyond his comprehension. If science wishes to lead, she must speak the same language as those she expects to follow her.

Despite the generally popular and practical character of the papers, there were a number presented which were of particular scientific interest and made distinct contributions to knowledge. Dr. Soren Hansen, of Denmark, showed that during the period since 1852 there has been an increase in the average height of adult Danes of 3.69 cm. He is of the opinion that the same thing has been true of other North European peoples. Professor Antonio Morro presented some interesting new statistical data regarding the influence of the age of parents on the psycho-physical characters of the children, tending to show that relatively young and relatively old parents produced a larger proportion of degenerate offspring than parents of medium age. M. Lucien March contributed a detailed analysis of French statistics on the relation of social status, social surroundings and income to the fertility of marriage. His results confirm and extend those of earlier studies in this field.

Dr. Frederick Adams Woods summarized the results of unpublished studies which he has made in historiometry, showing the preponderant influence of heredity in influencing the course of history. Professor Corrado Gini contributed a long paper dealing with the evidence obtained from demographic statistics on certain eugenic problems. The paper was a decidedly interesting one but impossible of brief review. Professor F. C. S. Schiller's paper on "Practicable Eugenics in Education" was an exceedingly keen analysis of the significance, from the standpoint of eugenics, of the existing educational system of England.

The social side of the congress was one of its most pleasant features. The hospitality committee, under the chairmanship of Mrs. Alec. Tweedie, arranged a series of banquets, receptions, teas, garden parties and excursions which made it possible for the members of the congress to meet not only one another, but also many of the most distinguished persons in English scientific, social, literary and public life.

Raymond Pearl

INDUSTRIAL EDUCATION IN THE PHILIPPINES

Under the leadership of American educators, Philippine education is making a remarkable advance. Indeed, according to recent reports received at the United States Bureau of Education, there are features of present-day education in the Philippines that are well worth the careful attention of school leaders in the United States.

It is in the field of industrial training and useful arts that the Filipinos, under American teachers, are making the most notable progress; such progress, in fact, that in certain lines—particularly lace-making and embroidery—the products of the Philippine schools not only compare favorably with the work of the famous French and Swiss experts, but promise to compete with them successfully in the world's markets.

The whole system of education in the Philippines is based on the principle that the children should receive training that will prepare them directly for the life they are to live. The boys receive manual training from the very beginning. In the lowest grades they make articles that they can use and sell, both in their own localities and elsewhere. The most important industry taught the boys is hat-weaving. It is a prescribed exercise in the primary schools. "The Bureau of Education at Manila considers it one of its legitimate functions to give such training in the making of good hats as will afford a large number of children a permanent means of earning a livelihood," wrote Mr. Frank R. White, Director of Philippine education, in 1910, after the courses had been introduced, and the development of the work has more than justified his claim. Chief among the products are the famous "buntal" hats, made from the leaf stem of the opened buri leaf. The schools do not attempt to replace hand machinery with modern apparatus, for it is recognized that there is a real demand for the products of careful handworkmanship. Besides the prescribed courses in the primary schools, there are regular grade schools, where the boys spend the greater part of the school-day in actual manual labor in the shops. A set of dining-room furniture in red narra, made at the Philippine School of Arts and Trades in Manila, sold for $200 at last year's carnival.

In the girls' schools plain sewing and housekeeping have generally formed the prescribed courses, but recently lace-making and embroidery have been introduced because they are arts which, besides possessing educational value, furnish the girls with a remunerative occupation. There were already in the Philippines young women who had learned embroidery and lace-making in the convents under the Spanish régime. Furthermore, because of their great natural aptitude for such work, and because of their patience and delicacy of execution, the Filipino women are considered among the most skilful workers in the world in these arts, their products being classed by experts as even superior to that of the French and the Swiss. The schools are, therefore, working on sure ground in teaching lace-making and embroidery, and they have ascertained that the demand for the kind of work their children can turn out is practically unlimited. In an effort to increase the available supply of teachers for the work, courses in lace-making and embroidery have been offered in the Philippine Normal School since 1910, and also in the various vacation assemblies of teachers.

The first thing a Filipino girl does in the sewing class in school is to make for herself a complete outfit of clothing. This work she usually begins in the second grade, but sometimes in the first or third. Armed with an embroidery frame and other apparatus (in most cases made by the boys in the same school), she advances in proficiency through the various grades; hemming and embroidering cotton squares, fine linen, handkerchiefs, waists, and so on. The more expert girls turn out masterpieces in French net and embroidery. In lace they make all varieties of "pillow lace," including "torchon" (Spanish lace), Maltese, Ceylon or Indian, Irish crochet, etc. Battenburg is also made for local use, but it is not encouraged for export, because the Japanese can make it more cheaply.

An idea of the extent of industrial education in the Philippines may be gained from the fact that nearly 400,000 school pupils are engaged in some kind of industrial work. For the past four years industrial instruction has been prescribed in the primary course for both boys and girls, and the work is systematically carried on in an advanced stage in the intermediate schools. Twenty-six well-equipped trade schools have been established in Manila and the various provinces; there is a college of agriculture at Los Banos, and a college of engineering has been added to the University of the Philippines. The Filipinos take to the educational program, industrial and otherwise, quickly and profitably; and the civil government finds its duties much less onerous now that the military invasion of the islands has been superseded by the educational.

GRADUATES FROM AMERICAN COLLEGES AND UNIVERSITIES

THE Boston *Transcript* has printed an article by Mr. Henry T. Claus, who gives the number of degrees conferred by 47 colleges and universities as follows:

College	Total No. Degrees in 1912	Total in 1902	Total in 1911
Allegheny	63	35	64
Amherst	95	97	96
Bates	91	57	92
Bowdoin	98	55	85
Brown	210	187	193
Bryn Mawr	77	68	70
Carnegie Tech	242	..	189
Clark	58	..	35
Colby	69	38	38
Colgate	72	37	48
Columbia	1,504	788	1,334
Grinnell	76	51	83
Hamilton	47	..	30
Harvard	1,000	1,033	1,003
Indiana University	372	124	347
Lehigh	85	45	95
M. A. C.	83	22	43
Middlebury	55	19	55
M. I. T.	286	200	253
Mount Holyoke	167	101	134
New York University	583	339	545
Northwestern	591	506	574
Ohio State	501	141	422
Penn State	266	28	247
Princeton	327	291	268
Radcliffe	117	100	84
Rensselaer	118	21	71
Rutgers	75	72	73
Simmons	95	..	73
Smith	372	229	360
Swarthmore	63	52	68
Syracuse University	480	207	417
Trinity	36	29	36
Tufts	238	137	214
Union	60	38	49
University of Cincinnati	191	121	158
University of Illinois	858	511	798
University of Maine	109	67	133
University of Michigan	1,143	858	1,093
University of Missouri	432	153	383
University of Pennsylvania	828	521	850
University of Pittsburgh	284	170	260
University of Vermont	96	80	109
Wellesley	299	155	289
Williams	93	67	97
Worcester Polytechnic	77	44	77
Yale	855	583	904

THE HARPSWELL LABORATORY

THE following persons have carried on investigations during the summer of 1912 at the Harpswell Laboratory:

Franklin D. Barker, associate professor of zoology in the University of Nebraska.

George A. Bates, professor of histology, Tufts College Medical School.

Henry B. Bigelow, assistant in the Museum of Comparative Zoology, Harvard University.

Margaret H. Cook, instructor in zoology, Wellesley College.

Ulric Dahlgren, professor of biology, Princeton University.

Charles H. Danforth, instructor in anatomy, Washington University.

Vincent Gregg, preparator in histology, Princeton University.

Robert W. Hall, professor of biology, Lehigh University.

Duncan S. Johnson, professor of botany, Johns Hopkins University.

W. O. Redman King, demonstrator in zoology, University of Leeds, England.

J. S. Kingsley, professor of zoology, Tufts College.

F. D. Lambert, associate professor of biology, Tufts College.

H. V. Neal, professor of biology, Knox College.

H. D. Senior, professor of anatomy, University and Bellevue Medical College.

L. E. Thacher, student, Tufts College.

Caroline B. Thompson, associate professor of zoology, Wellesley College.

Hardolph Wasteneys, assistant, Rockefeller Institute for Medical Research.

SCIENTIFIC NOTES AND NEWS

Sir W. H. White has been elected president of the British Association for the Advancement of Science for the meeting to be held next year in Birmingham.

Fordham University has conferred the honorary degree of LL.D. on Drs. Henry Head, of London, Carl Jung, of Zurich, Nicolas Achucarro, of Madrid, and H. R. Storer, of Newport, R. I.

On Thursday afternoon, September 12, 1912, at the Brooklyn Botanic Garden, a sweet gum tree (*Liquidambar Styraciflua*) was planted in the local flora section of the garden, by Professor Hugo de Vries, of Amsterdam. About one hundred invited guests were present at the exercises. A dinner was given in Professor de Vries's honor at 6 o'clock, and in the evening he delivered a lecture, under the joint auspices of the garden and the department of botany of the Brooklyn Institute of Arts and Sciences, on "Plant Breeding in the Botanic Garden of Amsterdam."

Dr. George Santayana, professor of philosophy at Harvard University, has resigned.

Mr. A. Wendell Jackson, who has arranged a loan of $50,000,000 to China, in opposition to the offers of the financiers of the six great powers, is a mining engineer who was formerly professor of mineralogy and economic geology at the University of California. He is a fellow of the American Association for the Advancement of Science and a fellow of the Geological Society of America.

Dr. Jean Mascart, of the Observatory at Paris, has been appointed director of the Observatory at Lyons, as successor to M. André.

Dean Milo S. Ketchum, of the College of Engineering of the University of Colorado, was recently elected president of the Colorado Association of Members of the American Society of Civil Engineers.

At the meeting of the Missouri Section of the American Chemical Society, held Friday evening, July 26, in the chemistry lecture room, University of Missouri, Mr. N. W. Arthur, research chemist of the General Electric Co., Schenectady, N. Y., spoke on a new electric furnace and new electric furnace products as SiO-monax and monas.

Dr. W. J. G. Land, of the botanical staff of the University of Chicago, sailed from San Francisco on August 27, for a trip of four months in the Hawaiian, Samoan, Fiji and Tongo Islands, with probably an extension through the New Hebrides to Australia. The chief purpose of the trip is to investigate the bryophytic flora and to secure critical material of it for morphological study. Incidentally, research material in other groups also will be secured.

Mr. and Mrs. C. William Beebe have returned from a three months' trip to Europe in the course of which the pheasants in the museums of London, Tring, Paris and Berlin were studied. The large series thus passed in review provided data for many generalizations hitherto impossible. A summary of the results will soon be published, the details of the work being reserved for the monograph on which Mr. Beebe is engaged, to be published under the auspices of the New York Zoological Society.

Dr. F. R. Watson, of the department of physics of the University of Illinois, has returned after a year's leave of absence. The year was spent almost entirely in Germany, where the universities of Berlin and Munich were attended, and special work was done in the subject of acoustics.

Professor Williston S. Hough, dean of the Teachers College and professor of philosophy at the George Washington University, Washington, D. C., died suddenly on September 18 at the age of fifty-two years.

Dr. John Wade, reader in chemistry in the University of London, known for his work in organic chemistry, was killed by a bicycling accident on August 15, aged forty-eight years.

M. Louis Crie, professor of botany at Caen, has died, aged sixty-two years.

The death is announced of Dr. Rudolf Hörnes, professor of geology at Graz, and distinguished for his work on earthquakes.

Professor Herman F. Wiebe, of the State Institute of Physics and Technology at Hamburg, died at the age of sixty years in New York City, where he had come to attend the International Congress for Testing Materials.

The International Congress of Mathematicians recently meeting at Cambridge adjourned to meet in Stockholm in 1916.

The fourteenth meeting of the Australasian Association for the Advancement of Science will be held in Melbourne in January, 1913.

The International Congress on Hygiene and Demography opened on September 21. President Taft, honorary president of the congress, opened its session at 11 o'clock on that morning. The delegates number some 2,800, representing thirty-three foreign governments, every American state and territory, over 300 American cities, leading colleges and universities here and in Europe, and many scientific, medical and social institutions throughout the world. In addition, many eminent visitors are in attendance. The congress is divided into eleven sections and four general sessions have been arranged. Dr. Henry P. Walcott, chairman of the State Board of Health of Massachusetts, is president of the congress. The presidents of the sections are as follows:

Professor Theobald Smith, Harvard Medical School, Boston, Hygienic Microbiology.

Dr. Russell H. Chittenden, professor of physiology and chemistry and director of the Sheffield Scientific School of Yale, Dietetic Hygiene.

Dr. A. Jacobi, New York City, president of the American Medical Association, The Hygiene of Infancy.

Dr. Lewellys F. Barker, professor of internal medicine of Johns Hopkins University, Mental Hygiene.

Dr. George M. Kober, professor of hygiene at Georgetown University, The Hygiene of Occupations.

Dr. Hermann M. Biggs, medical director of the department of health, New York City, The Control of Infectious Diseases.

Dr. Frank F. Wesbrook, professor of pathology and bacteriology of the University of Minnesota, State and Municipal Hygiene.

Dr. Prince A. Morrow, New York City, Sex Hygiene.

Dr. Rupert Blue, Surgeon General of the United States Public Health Service, The Hygiene of Traffic and Transportation.

Dr. Henry G. Beyer, U. S. N., Military, Naval, Tropical and Colonial Hygiene.

Professor Walter F. Willcox, president of the American Statistical Association, Cornell University, Demography.

Dr. W. S. Bruce, the Scottish explorer, has arrived at his home near Edinburgh, from his surveying expedition with Dr. R. N. R. Brown in Spitzbergen. According to the London *Times* the explorers have made a detailed topographical survey of the region traversed by them and a general geological investigation. They traveled from Bjona Haven to Advent Bay by a new route over land in which, so far as is known, reindeer, ptarmigan and other game used to abound. In the whole journey of nearly 60 miles, however, not a ptarmigan, fox or reindeer, except skeletons and rotting carcasses, was seen. Dr. Bruce strongly condemns the wholesale extermination of animal life carried out in Spitzbergen, not only by gun and trap but by poison. Norwegian hunters, he says, habitually put down poisoned bait for bears, foxes and other animals, and he holds that strict measures should be taken to protect the fauna of Spitzbergen, which at present is being rapidly and ruthlessly destroyed. A great development of the coal mines, chiefly under the auspices of American capital and enterprise, and of other mining activities financed by British capital, was observed. There is activity also on the part of the Norwegians, who are developing means of communication by post and wireless telegraphy.

The Colorado Geological Survey has had three parties in the field during the summer of 1912. One party, under the direction of Assistant Professor Ralph D. Crawford and Mr. Philip G. Worcester, has continued the work begun last season in the Goldbrick district. A second party, under the direction of Professor H. B. Patton, of the Colorado School of Mines, has spent the summer in the Bonanza Mining district near Villa Grove. A third party, directed by Dr. George I. Finlay, of Colorado College, has been at work on an investigation of the water resources of the Arkansas Valley region.

Charles Richmond Henderson, head of the department of practical sociology in the University of Chicago, has been given leave of absence by the university trustees during the autumn quarter of 1912 and the winter quarter of 1913, to act as the Barrows lecturer in India. The Barrows lectures are given every three years in the principal cities of India, on the foundation established by Mrs. Caroline E. Haskell. The general purpose of the lectureship is to consider the relation of Christianity to other religions. Professor Henderson will lecture in some of the cities of Japan and China on his return to this country. His predecessor on the Barrows Foundation was Charles Cuthbert Hall, former president of Union Theological Seminary, New York. Professor Henderson's lectures in India will be issued in book form by the University of Chicago Press.

UNIVERSITY AND EDUCATIONAL NEWS

At the September meeting of the Yale Corporation it was announced that since the last meeting three wills have been filed for probate from which the university should receive during the year about $750,000. These include $250,000, unrestricted, by bequest of Matthew C. D. Borden, Yale, 1864; $25,000 from Cyprian Brainerd, of the class of 1850, for the use of the medical department, with ultimately an additional $40,000 after the death of certain beneficiaries, and the McPherson fund of between $400,000 and $500,000, "to be employed in assisting worthy indigent students." This bequest is due to the death of Aaron S. Baldwin, executor of the will of the widow of Senator McPherson, of New Jersey. Mrs. McPherson's will provided for this bequest. Announcement was also made that $10,000 had been received from the Misses Kingsbury as a history publication fund in memory of the late Frederick John Kingsbury, of Waterbury, for many years a member of the Yale Corporation; also $5,000 from Mrs. Arthur Ryerson, widow of the late Arthur Ryerson, Yale, 1871, to establish the Arthur Larned Ryerson scholarship in Yale College in memory of her son; also $3,000 from Francis D. Hurtt, 1907, Law School, to establish the Sarah Ives Hurtt scholarship in the Law School.

Professor William D. Harkins has removed from the University of Montana to the University of Chicago, where he will have charge of the research work in general chemistry, and will give courses in inorganic and general chemistry. His position as professor of chemistry in the University of Montana has been given to Dr. R. H. Jesse, instructor in chemistry in the University of Illinois. Mr. W. G. Bateman, former professor of chemistry in the Imperial Chinese University, has been appointed instructor in chemistry in the University of Montana, in place of Mr. J. W. Hill, who has resigned.

DR. MADISON BENTLEY, assistant professor of psychology in Cornell University, has been called to the chair of psychology in the University of Illinois. Dr. H. P. Weld, of Clark University, becomes assistant professor of psychology at Cornell.

DR. W. F. BOOK, of the University of Montana, has accepted an appointment as professor of education in the University of Indiana.

THE department of physics of the University of Illinois has added two new assistants to its teaching staff for the present year, Mr. W. H. Bair, for some time a teacher of science in the high schools of Illinois, and Mr. Earle H. Warner, assistant for several years in the department of physics of the University of Denver. Both men are to serve as half time assistants.

DR. ALVIN R. PEEBLES, formerly professor of the theory and practise of medicine in the University of Colorado, has been appointed head of the department of preventive and experimental medicine, which has been established by the regents.

DR. THOMAS CLACHAR BROWN, a graduate of Amherst, who received his doctorate from Columbia in 1909 and who has since filled the positions of assistant professor of geology at Middlebury College and assistant professor of geology at the School of Mines, Pennsylvania State College, has been appointed associate in geology at Bryn Mawr College.

MISS MARY D. MACKENZIE, professor of biology at Western College, Oxford, Ohio, has been appointed head of the biology department of the Margaret Morrison School for Women of the Carnegie Institute, Pittsburgh.

PROFESSOR J. LORRAIN SMITH, F.R.S., professor of pathology and pathological anatomy in the University of Manchester, has been appointed to the chair of pathology in the University of Edinburgh, in succession to Professor W. S. Greenfield.

DR. J. STILLE, of the Technical Institute at Hanover, has been appointed professor of geology and paleontology at the University of Leipzig.

DISCUSSION AND CORRESPONDENCE

THE POLICY OF THE GEOLOGICAL SURVEY

TO THE EDITOR OF SCIENCE: In his paper on "A National University," printed in the issue of SCIENCE of August 16, President Van Hise takes occasion to comment on the neglect of science by the scientific bureaus. He states that the United States Geological Survey "is almost exclusively a department of practical geology" and "is not contributing in any large way to the advancement of science."

President Van Hise seems to be comparing the Geological Survey in the first decade or so following its organization with the larger service of to-day. As I am in part responsible for the Survey's present policy, I may perhaps be permitted to present this matter in its other phases. The question whether his statement is justified is not easily debatable, for the premises on which any argument should rest are not of a kind readily agreed upon. In fact, President Van Hise and other geologists might disagree as to what constitutes "advancement of science," and as to what is "practical geology." This unavoidable confusion of definition prevents any adequate comparison of past and present contributions or even of an earlier and the present personnel.

With this inherent difficulty in discussing generalities, it becomes especially a matter of regret that President Van Hise contented himself with reiteration of the charge, without definition of his terms or mention of any supporting facts. The question therefore resolves itself into a consideration of the degree of truth or justice in President Van Hise's two dicta: the Survey is "almost exclusively a department of practical geology," and "it is not contributing in any large way to the advancement of science." These deserve to be considered separately, because I can not admit that the one is a corollary of the other.

Geologic research as conducted under government auspices should, in my opinion, be largely practical. The purposes for which the United States Geological Survey was organized, both as specified by Congress and as recommended by a committee of the National Academy of Sciences, are practical, and the administrator who would venture to disregard the plain intent of that legislation would not contribute to the ultimate advancement of science. The Survey began on very practical lines, Director King arranging the initial work in districts offering "examples of instructive geological structure and great bullion yield," and even that classic work of science planned as the first monograph of the new survey, "Lake Bonneville," had its practical side, the hope having been expressed by Mr. Gilbert himself in a report of progress "that a critical investigation of the secular oscillations of climate in the past will help to solve the problem of secular change which is of such vital importance to the agriculture of an arid domain."

The most recent index of the trend of the Survey's work is afforded by the schedule of manuscripts being edited August 15, which affords some basis for judging of the character of the publications now in hand. The publications issued each year are known to the public, although I might mention as noteworthy in this connection two contributions that are just coming from the press: Monograph LI., "Cambrian Brachiopoda," by Walcott, and Professional Paper 71, "Index to North American Stratigraphy," by Willis. Of the 41 reports now being edited 5 are engineering bulletins, embodying data incidentally collected in the course of topographic surveys, and therefore not chargeable to scientific appropriations; 8 relate to Alaska and represent work done under an appropriation made specifically "for the investigation of mineral resources" and therefore not to any large extent available for theoretical investigations, though the results of the work in Alaska are a splendid contribution to our knowledge of the geology of the globe; 8 are water-supply papers contributed from the work under another specific appropriation; 6 relate to economic geology; and the remainder, 14, may fairly be described as outside the "department of practical geology." This group of 14 includes 6 paleontologic reports, 3 descriptions of areas having no special economic importance, and one report under each of the following subjects—glaciers, Pleistocene geology, petrography, stratigraphy and mineralogy.

That the United States Geological Survey concerns itself with the practical side is true now as it has always been in the past; whether its work is more or less devoted to practical geology than formerly can be decided according to one's taste or prejudices; but that it is almost exclusively a department of practical geology must be denied.

Besides making general investigations in geology and highly specialized researches in paleontology, petrography, mineralogy, geophysics and geochemistry, which it will be generally agreed contribute to the advancement of science, the Survey is making other investigations whose theoretic results are so closely combined with the results of practical geology that their scientific value may be overlooked by some readers. In some cases the "purely scientific" conclusions reached are incidental to the practical investigation, but in many instances are essential to it. To-day, as in the past, the study of ore deposits by the Geological Survey continues to yield a large measure of scientific results of the highest grade, and the five manuscripts on economic geology mentioned above are no exception to this rule. Most of these are not detailed descriptions of mining camps, but deal to a great extent with the areal geology and physiography of the hitherto blank spaces on the geologic map of the United States. The broader studies are not neglected—a fact illustrated by a manuscript just received from Professor W. H. Emmons on "Secondary Sulphide Enrichment," which represents results gained in the course of economic work in several mining districts during the past twelve years. That the answers to the problems of chemistry and physics here discussed possess a practical present value to the mining engineer in nowise detracts from their permanent value to the broad science of geology.

An example of work on a broad problem that concerns a number of states is afforded by the general and detailed study of the Atlantic and Gulf Coastal Plain which for five years has been prosecuted under the direction of T. W. Vaughan with the cooperation of several state and federal geologists. Similarly, the mapping of the San Juan region by Whitman Cross serves as a notable example of a general investigation of broad scientific interest, covering two decades. A third illustration is to be found in the geologic work of Messrs. Campbell and Alden in the new Glacier National Park. It is conceivable that the publications resulting from such geologic investigations will stand as large contributions to science, and when this literature has been illumined by the added glamor of the years, the Geological Survey of to-day may be cited as again "the center of the world for the advancement of the science of geology."

More than this, the application of geology to economic problems has a reflex effect upon the science. The association of the scientist with the engineer is beneficial to both. The geology that is applied to big problems, whether of engineering or of governmental policy, must be not only qualitatively true, but also quantitatively exact. So the entrance of the Geological Survey into the administration of the public lands has modified field methods and established standards of accuracy not before demanded. The result is that the geologist who works in terms of forty-acre tracts observes details that were overlooked by his predecessor who looked the country over by the square mile.

The recognition of the applicability of geologic data collected by government scientists to the administration of the public lands is in itself, I believe, a large contribution to the advancement of science. The field of science is broadened and the standing of science is dignified. The remark of the geologist whose experience had been gained largely in the east but who is now working in a western mining camp illustrates this: "It is a satisfaction to be looked upon as a worker and not have to make apologetic explanations as to what geology means."

Another illustration is afforded in the work of the Geological Survey in connection with the proposed forest reservations in the east. For years the geologists and hydrographers of the Survey had taken interest in the question of the relation of forest cover to stream flow and as opportunity afforded had made observations bearing on the question. The results, however, were at best only qualitative and to some extent confusing. The Weeks Act, however, specifically laid upon the Survey the burden of making an affirmative showing of the regulative effect of the forest upon stream flow, before land could be purchased, and then an investigation was planned with the purpose of obtaining conclusive results. That the Survey withstood popular clamor until its investigation was concluded and reported only on observed facts may of itself have been a possible aid in advancing science. As an intensive study, the hydrometric survey of selected areas in the White Mountains is believed to be without parallel in the world, and it has yielded quantitative results which, when thoroughly digested and compiled, will be published as an important contribution to science. This opportunity to apply science to an administrative problem came to the Geological Survey because its work was believed to be both practical and scientific; and I may add my opinion that whenever this bureau becomes exclusively "practical" or exclusively "scientific" it will cease to deserve either recognition or support. This idea has been best expressed by Brooks: "Applied geology can maintain its present high position of usefulness only by continuing the researches which advance the knowledge of basic principles."

Geo. Otis Smith

SCHOOL GRADES—TO WHAT TYPE OF DISTRIBUTION SHALL THEY CONFORM?

Those administrators who have given the subject of scholarship marks or school grades considerable attention, will appreciate President Wm. T. Foster's article, "The Scientific

Distribution of Grades at Reed College," which appeared in the June 7, 1912, issue of Science.

Without wishing to criticize the Reed College system which the writer considers amply adequate to bring about uniformity in grading at Reed College itself, there yet remains the question, is the Reed College system the one most likely to be adopted by other educational institutions? The extent to which the question of grading is at present agitated justifies the conclusion that there is a tendency toward the standardization of grades—not only within the walls of a given school, but among the schools themselves. As long as no absolute units for mental measurement exist, the one essential factor for standardized grades is that the *form* of the distribution of these grades be identical for the various institutions. If this is true, the question arises what form of distribution shall be adopted?

The form adopted by Reed College is a modification of the normal curve, *skewed* to take account of the "selected nature of college students." It is this question—the advisability of skewing the normal curve—which is to be considered in this paper.

From present indications, if the various educational institutions throughout the country were suddenly obliged to adopt a uniform type of distribution for their grades, it is probable that the normal type of distribution is the one which would be most readily accepted. As soon as deviations, either in one direction or the other, are suggested, each faculty would insist on skewing the curve in the direction which would best express, in the opinion of the faculty, the local conditions. If the different school faculties are encouraged to express in their grades the degree of selection which they believe to exist in their student body, the personal element will again become so strong as to eliminate the uniformity which a scientific system is supposed to introduce. In a faculty composed mainly of "home talent" there is a tendency to suppose that its particular students are a specially selected group with respect to intelligence, and under such conditions it may happen that a faculty will adopt a form of distribution in which *all* of the students are supposed to be above the general average instead of only three fourths, as is done in the Reed College curve.

Until a system of absolute mental units has been invented, it is futile to try to make grades represent absolute accomplishment. The best that can be done under the conditions is to let the grades express *relative* accomplishment. It should be clear that skewing the normal curve is an attempt to make grades represent absolute accomplishment in that the degree of deviation from the normal type of distribution is supposed to measure the degree of superiority or inferiority, above or below some hypothetical absolute accomplishment of the population at large. Since we do not know enough about the intellectual capacity of the population at large to gain general acceptance for such numerical values as we might choose to assign, perhaps it would be better, for the present, to be satisfied with measuring relative accomplishment. To justify the deviation from the normal curve shown by the Reed College system, it seems that the following two factors should permit of quantitative statement.

1. The *numerical degree* of the selection with respect to *scholarship.*

2. The difference in the *form* of the distribution of the selected group, from that of the unselected group.

With respect to (1) it is doubtful whether the data at our disposal are of such convincing validity as to justify our giving it numerical values, especially when we consider not only those students who fail to attend the university after finishing their high-school work, but also those who drop out during the first, second and third high-school years. Many students leave high school because their parents have not the means to enable them to continue; some students get dissatisfied with the school work and prevail upon their parents to let them go out and do "real work." It is not necessary here to indicate the many reasons for which children leave the high school—reasons which have nothing to do with the intellectual ability of the student. The percentage of successful men and women who have never completed a high school course is still too large to warrant the conclusion that the elimination which takes place can be accurately expressed in terms of scholarship. That some selection with respect to scholarship takes place may very well be admitted but at present we are not in a position to isolate this from the numerous other factors which make college enrollment less than that of the high schools.

Further, to assume that 75 per cent. of its students are above the general average, as is done in the Reed College system, is a verdict which should come from some other source than Reed College. If it is found, for instance, that Reed College graduates invariably do better work than the graduate students from other schools, it would be possible to calculate the superiority of Reed College students. This is the only sense in which the term selection would have any significance. It is the product, not the raw material, which should characterize a school.

Reed College could also calculate the relative standing of the high schools from which it draws its students. This would be a comparatively simple task if all the high schools graded their students in strict compliance with the normal curve, but if the several schools adopted curves which deviated from the normal, each school deviating to the extent which most appealed to it, an attempt at fixing a definite value for a particular grade would be almost as hopeless a task as it is now.

If, however, all educational institutions awarded grades strictly in compliance with the normal curve, these grades would at least express the same *relative* scholarship. If then the graduate schools found that the students from one institution did better work than students having the same grade from other institutions, the graduate schools could easily calculate a selection coefficient which would express the degree of selection for the different schools. Of course, this can not be done at the present time, but the writer merely wishes to point out that the factor of selection can not be scientifically evaluated with the data now at our disposal. To encourage a faculty to express this ambiguity in its grades is only transferring the grading idiosyncrasies from the individual instructor to the faculty.

With respect to (2), it is questionable whether the selection of scholarship which exists is of such a nature as to change the *form* of the distribution in a measurable degree. It is of course to be understood that the average accomplishment of a poor class may be less than the average accomplishment of a better class, but it does not follow that the grades are distributed differently on either side of the respective class averages.

An elementary class in experimental psychology of about 150 students at the University of Missouri were graded for a whole semester according to the average accomplishment of the whole class. The Ebbinghaus conjectural method of examination was used so that the personal equation of the instructor might be eliminated as much as possible, and also to approach more closely to the absolute accomplishment of the students.[1] The correlation between the actual grades and those expected from a normal type of distribution was then calculated according to the following scheme.

Number of Examinations	Extent of Correlation with Normal
1	.730
2	.970
9	.996

We have here a gradual approach toward the normal type of distribution. If only a single examination is given the distribution may be decidedly skewed. This does not, however, show conclusively that the scholarship is not normally distributed. If the examination does not fairly test the scholarship of the

[1] A more detailed report of this investigation is to be found in *The Journal of Experimental Pedagogy and Training College Record* (Sheffield), Vol. 1, No. 4, June, 1912.

class, if it is too easy or too difficult, a skewed distribution may result even if the scholarship of the class is actually normally distributed. In the above investigation, as the number of examinations increased there was a closer approach toward the normal type of distribution and when nine tests had been given the actual distribution was practically identical with that of the normal type. This was also true for the elementary classes in chemistry. In general it is the writer's experience that as the methods of examination are refined and as the number of students and the number of tests is increased there is a closer and closer approach toward the normal curve. Mathematically speaking, the normal curve seems to be the limit which, with refinement of method and the elimination of accidental variations, tests of general intelligence approach. It is to be remembered that these students were university freshmen and sophomores upon whom the effects of high school selection have been operative. It is possible that if all the high-school classmates of these students had continued and taken the same course in the university the average accomplishment of the whole class might have been somewhat less, yet it is not likely that the *distribution* would have been different.

That some mental tests are not normally distributed need be no cause for criticism when we recall that the essential factor in grading is *uniformity*. What a particular grade will eventually signify will depend upon how successfully or unsuccessfully the students who are characterized by this grade meet the demands of higher institutions or the demands of the world at large. It will not depend upon whether the grade is found below or above some hypothetical accomplishment of the population at large.

There is another question which might be asked, namely: How many of the ten grades awarded by Reed College represent distinguishable degrees of scholarship? At the University of Missouri only five different grades are awarded, and from working with the records of these students the writer is inclined to believe that students who are only a little above or below the average in some courses tend to approach closer to the average when the grades in their other courses are taken into account. If this is a fact then it is possible that the Reed College grades 5, 6, 7, do not represent different degrees of scholarship. There is no way of determining this at the University of Missouri, but Reed College has the data for making this investigation. If three series were to be formed as follows:

Series I.—Students whose grades are between and including the limits 4–6. (Those students who have no grade higher than 4 nor a grade lower than 6.)

Series II.—The same for the grade limits 5–7.

Series III.—The same for the grade limits 6–8.

If after credit units are considered the averages of these three series are not respectively 5, 6, 7, but approach more closely to each other, say 5½, 6.0, 6½, this would show that the grades 5, 6, 7, do not represent distinguishable degrees of scholarship. It would, no doubt, be of considerable interest to school administrators to have a report from Reed College on this point.

In conclusion we may summarize the arguments in this paper as follows:

Such mental tests as are significant for determining school grades approach the form of the distribution of the normal curve. The deviations from the normal curve may be considerable, but some of the deviation is due to factors other than those of scholarship. Where the deviation is due to a number of interrelated causes it is difficult to assign a value to the effect of a single one of them. In the interest of uniformity in grading it is essential that the *form* according to which the grades are distributed be *the same for the different schools.* Since the normal curve is a purely theoretical invention closely approximating the actual conditions and is at the same time not hampered by empirical considerations, its mathematical simplicity and the relatively extensive knowledge which we have of its properties, seem to commend it as the most useful curve to represent the type of distribution to which scholarship marks should conform. If it is desirable to have the grades express significant local factors, this can always be done by adding some constant value to these grades, and the constants so found will also give an index as to the scholarship of a particular institution.

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SCIENTIFIC BOOKS

Nature's Harmonic Unity. By SAMUEL COLMAN, N.A. Edited by C. ARTHUR COAN, LL.B. New York, G. P. Putnam's Sons. 1912. Cloth, $8 \times 9\frac{1}{2}$ in. Pp. viii + 327; 302 illustrations. $3.50 net.

The purpose of this book appeals to the scientist and ought to be a matter of serious study for every beginner in the vocation of arts.

It contends to prove that pleasing forms of nature, as well as of human creation, are ruled by mathematical laws.

That this is true to a certain extent has been shown by the reviewer in an article on "Mathematical Principles of Esthetic Forms," which in October, 1900, appeared in the *Monist,* and in various other publications,[1] where also a number of important references may be found. The fact that the author does not seem to be familiar with these accounts for some serious defects in the presentation of the subject. A writer who attempts to explain the principles of esthetic forms in nature should not neglect to study, for example, Schwender's "Vorlesungen über Mechanische Probleme der Botanik."[2] Furthermore, what a rich source of beautiful natural forms might he find in Haeckel's "Kunstformen der Natur."[3]

In neglecting the physiological and psychological factors of the problem, the treatment must necessarily become antiquated and, from the standpoint of the exact scientist, in many parts shrouded by a semi-mathematical mythology and naïvely stated principles.

The book contains, nevertheless, a number of very readable chapters which will be of value to any one interested in the problem. The examples chosen from biology are by far the most interesting, while some of those in architecture are of questionable value. See, for instance, on page 79, the combined figure of a snow crystal and the Parthenon. It is evident that a hexagonal figure may always be drawn to fit the tinted square and resembling a snow crystal. But what about the exact dimensions? Again, the paraphrase of a vase, p. 273, designed according to, what in this and similar cases I call mathematical mythology, is certainly no object of universal admiration. Notice the painfully weak points in the foot.

The Greeks did not know the logarithmic spiral as would appear from a statement in connection with the discussion of the Ionic volute in the chapter on conchology. This particular spiral, expressed by the polar equation $\rho = e^{a\theta}$, was discovered by Descartes in 1638. When writing about the Ionic order, why not mention the Lituus ($\rho^2 = a^2/\theta$) discovered by Cotes in 1722. It seems strange too, that the catenary should be given the prize as the most beautiful curve. Those algebraic lines which pass through the circular points are generally considered as the beauties among the curves.

The technical aspect of the book is generally pleasing. It is, however, to be regretted that in a treatise with esthetic purposes most of the geometric figures should be so crudely drawn. They are clumsy-looking and lack neatness and precision of execution.

[1] "Mathematik in Natur und Kunst," *Mitteilungen der Naturforschenden Gesellschaft in Solothurn,* Vol. XV., 1906. "Sur quelques exemples mathématiques dans les sciences naturelles," *L'Enseignement Mathématique,* Vol. XII., Paris, 1910. "Wiskunde en Natuurlijke Historie," *Wiskundig Tijdschrift,* Vol. 10, Haarlem, 1910. "Mathematics and Engineering in Nature," *Popular Science Monthly,* November, 1911.

[2] Engelmann, Leipzig, 1909.

[3] Leipzig, 1899–1903.

We fully agree with the author when he states:

Proportion is a principle in nature which is a purely mathematical one and to be rightly interpreted by man through the means of geometry; therefore geometry (?) (mathematics) is not only the gateway to science but is also a noble portal opening wide into the realms of art. Still to a great majority of artists, and to the world at large, the effort to relate science with art is now looked upon with the greatest disfavor and even repugnance, and this accounts in a measure for the overwhelming percentage of immature work which characterizes all branches of art in our times.

It would be another extreme, however, to try to explain all natural forms and everything in art by stereotype mathematical laws. This would soon lead to barren formalism and sterility. True art in many of its phases must conform with mathematical, or, more generally, scientific principles. But it can not live without the inspiration derived from physiological and psychological factors.

Colman's book on "Nature's Harmonic Unity" serves a very noble purpose: a rational appreciation of beautiful natural forms and, based upon it, the cultivation of a truly artistic spirit.

It is for this reason that, in spite of its defects, we wish a large circle of readers for it.

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A Revision of the Amphibia and Pisces of the Permian of North America. By E. C. Case. Washington, Carnegie Institution, Publication No. 146. 1911. Pp. 179, text figs. 56, plates 32.

This monograph is the third of a series by Dr. Case on the Permian vertebrates of North America. The work is divided into five parts: an historical review, a systematic revision, and a morphological revision of the Amphibia, a description of some Permian insects by Dr. E. H. Sellards, and a review of the Permian fishes of North America by Dr. Louis Hussakof. The historical review shows the development of the taxonomy and nomenclature of the Permian vertebrates from the earliest descriptions by Cope in 1875 to the time of publication.

In the systematic review the author has been very conservative and has rejected the more recently proposed classifications of the Amphibia. The one adopted is, in general, that most commonly in use for the Stegocephalia. Under this order two suborders are recognized, the Microsauria and the Temnospondyli. The author has used the term Microsauria (with question) in the sense commonly employed and has made no attempt to define this sadly mixed group. To it are referred the family Diplocaulidæ and genus *Diplocaulus.* The suborder Temnospondyli is divided into two groups, the rhachitomous and the embolomerous. Under the first division are placed 12 genera arranged in five families: family, Eryopidæ, genera, *Eryops, Parioxys, Anisodexis* (?), and *Acheloma;* family, Trimerorhachidæ; genera, *Trimerorhachis, Tersomius* and *Zatrachys;* family, Dissorhophidæ, genera, *Dissorhophus, Cacops* and *Alegeinosaurus;* family, Aspidosauridæ, genus, *Aspidosaurus;* family, Trematopsidæ (not Trematosauridæ), genus, *Trematops* (not *Trematosaurus*). The embolomerous division is represented by the family Cricotidæ and genera *Cricotillus* and *Cricotus.* Under the heading, "Incerte sedis," are placed, family, Crossotilidæ, genus, *Crossotelos;* family, Gymnarthridæ, genera, *Cardiocephalus* and *Gymnarthrus;* all referred to the suborder, Gymnarthria. Under the second order represented, the Urodela, is placed the family Lysorophidæ and genus *Lysorophus.* In this Dr. Case agrees with the majority in considering *Lysorophus* an amphibian in opposition to the few that still believe it a reptilian form. At the end of this section is a set of tables showing the characteristics of the various families, genera and species. These are so arranged that the related forms can readily be compared.

In the morphological revision the following genera are treated in detail: *Diplocaulus, Eryops, Acheloma, Trimerorhachis, Zatrachys, Dissorophus, Cacops, Gymnarthrus* and *Lysorophus,* genera which, till recently at least, were but little known. In an attempt to bring the publication up to date the author has drawn freely from Williston, Broili and others in this part of the work.

The description of two new cockroaches by Dr. Sellards is of special interest, as these are the first insects to be described from the Permian of Texas.

In the discussion of the Permian fishes of North America, Dr. Hussakof points out that Cope, in a series of papers between 1875 and 1894, created several species without justification because of too fragmentary material or the failure to allow for individual variation. Through a restudy of Cope's types in the American Museum, the Gurley Collection at the University of Chicago, and with the addition of new material, Dr. Hussakof has added four new genera, which makes 14 in all. Curiously enough, however, because of subtractions and additions, the number of species is 22, the same as was given by Cope. In an appended table of comparisons some interesting things are brought out; it is pointed out that the Illinois fish fauna, with the exception of one group, the Petalodontidæ, is duplicated in the Texas fauna, a condition that indicates a close relation between the faunas of these two remote regions. A comparison of the Texas fauna with that of Bohemia shows a marked difference in the genera of the two localities, although, with one exception, the groups represented in each are the same. From this the author draws the conclusion that although the faunas must have arisen from a common stock, the two regions had long been separated before Permian times.

Through oversight, most likely, a few mistakes, of minor importance, perhaps, have been made to which attention should be called. The statement is made that *Ophiacodon mirus* Marsh and *O. grandis* Marsh, which Marsh considered reptiles, "are clearly amphibians of uncertain relationships." Williston has recently shown that *O. mirus* is a reptile and that *O. grandis* belongs with *Eryops*.

Pleuristion, which is evidently considered an amphibian and is placed under the Gymnarthria without comment, was treated by Dr. Case in his "Revision of the Pelycosauria" (p. 27). Here he is in doubt as to whether the genus is more closely allied to the Pelycosaurs or the Cotylosaurs. From evidence furnished by the humerus, as described and figured by Williston, as well as the vertebræ, *Pleuristion* is, in all probability, a cotylosaur and probably a member of the Captorhinidæ.

In the description of the humerus of *Diplocaulus* (p. 90) Dr. Case expresses the opinion that it may be reptilian. To quote:

"This [*Diplocaulus*] is the single case among the *Amphibia* of the Texas Red Beds, or their equivalent elsewhere, in which the entepicondylar foramen has been found in the humerus. The opening in the humerus of *Acheloma cumminsi* is purely accidental in the opinion of Williston, Broom and the author. For this reason it is possible that the humerus may be reptilian and in accidental association."

This hardly seems possible as these humeri are found associated with many specimens of *Diplocaulus* in the University of Chicago collection. And, furthermore, according to Broili, *Cochleosaurus*, an Upper Carboniferous Temnospondyl, has the entepicondylar foramen present in the humerus.

The present work will be of great interest to all paleontologists and of inestimable value to the student of Permian vertebrates. The compilation is so complete that it will no longer be necessary to turn to the original papers on these groups for the information desired. The text is illustrated with a great many new figures as well as copies after Broili, Williston and others. The plates, too, are worthy of special mention.

Maurice G. Mehl

NOTES ON INFECTIOUS ABORTION IN CATTLE

In recent numbers of Science Dr. Russell[1] and Dr. MacNeil have called attention to the fact that infectious abortion of cattle in this country is undoubtedly caused by the same organism as that found in Europe. It may

[1] Russell, H. L., Science, N. S., Vol. XXXIV., October 13, 1911, p. 494. MacNeil, W. J., Science, N. S., Vol., XXXIV., December 22, 1911, p. 874.

be of interest to very briefly review certain recent publications dealing with this disease. This is particularly true just at present, as it seems possible that this disease may have more than a passing interest for human medicine.

From the standpoint of the veterinarian the most important recent work is that from the laboratory of Dr. C. O. Jensen in Copenhagen, Denmark. This laboratory has devoted particular attention to the study of reliable methods of diagnosis. In September, 1909, Dr. Holth[2] published a preliminary report, on the use of agglutination and complement fixation for determining the presence of this disease.[3] During the past year Sven Wall, working under the direction of Drs. Jensen and Holth, has published[4] the account of extensive tests with these methods. Wall gives the details of the examination of eleven hundred (1,097) cows by the use of both methods. In many cases the cows were tested every month for from six to eight months. On the basis of this work Wall concludes that it is entirely possible by the combined use of these two methods to determine which cows are infected, or at least which ones have been infected within the last six or eight months. It should be noted here, however, that these serum tests offer no opportunity to distinguish between cows which have an active infection and those which have acquired a measure of immunity. Wall's work, however, indicates that the agglutinins and immune bodies gradually disappear. In from six months to a year after the infection, it is usually not possible to demonstrate the presence of these bodies.

The work of Holth and Wall has been corroborated by a number of recent investigations dealing with this disease. Professor Zwick, of the Veterinary Division of the Royal Health Bureau in Berlin, has contributed several recent papers.[5] He concludes that the methods of agglutination and complement fixation offer the proper means of diagnosis in this disease. Zwick also concludes that infectious abortion is much more widely spread among cattle than is usually believed. He further believes that infectious vaginitis is not a cause of abortion, but that the abortion in such cases is due to a separate infection with the Bang bacillus. Another paper dealing with the diagnosis of abortion is by Brüll[6] from the veterinary school in Wien. Brüll, using the agglutination method alone, found that the serum of cows which had aborted agglutinated the abortion bacilli in dilutions from 1 to 64 up to 1 to 16,000. The cows which had not aborted and came from farms where there had been no abortion never showed agglutination in dilutions higher than 1 to 64 and usually much lower. He concludes that this method may be used with success. All cows showing agglutination higher than 1 to 64 are believed to have been infected.

Still more recently MacFadyean and Stockman,[7] of the English Abortion Committee, have thoroughly tested the agglutination method. Of 535 steers, bulls and calves, which *a priori* were assumed to be non-infected, only nine showed agglutination in the dilution of 1 to 50, four in the dilution of 1 to 100 and only one in the dilution of 1

[2] Holth, Halfdan, "Die Agglutination und die Komplementbindungsmethode in der Diagnosis des Seuchenhaften Verwerfens der Kühe," *Berl. Tierärzt. Woch.*, Bd. 25, pp. 686–688, 1909.

[3] In the same year and independently, MacFaydean and Stockman, of the English Abortion Committee, also pointed out the possibility of using these methods.

[4] Wall, Sven, "Om Diagnosticering af infectoes Kastning hos Kvaeget ved Agglutination og Komplementbindung," *Maanedsskrift f. Dyrlaeger* XXI., 1910. Also "Ueber die Festellung des seuchenhaften Abortus beim Rinde durch Agglutination und Komplementbindung," *Zeit. f. Infektionskr. usw. der Haustiere*, Bd. 10, 1911.

[5] Zwick, *Central. f. Bakteriol. usw.*, Bd. 47, I. Abt. Ref. (Beilage), 1910; *Berl. Tierärzt. Woch.*, Bd. 27, No. 6, pp. 111–112, February, 1911; *Berl. Tierärzt. Woch.*, Bd. 27, No. 52, pp. 965–969, December, 1911.

[6] Brüll, Ziga, "Beitrag zur Diagnostik des infektiösen Abortus des Rindes," *Berl. Tierärzt. Woch.*, Bd. 27, pp. 721–727, 1911.

[7] MacFadyean, Sir John, and Stockman, Stewart, "The Agglutination Test in the Diagnosis of Bovine Contagious Abortion," *Jour. Comp. Path. and Therap.*, Vol. XXV., pp. 22–38, March, 1912.

to 200. On the other hand, of 127 cows which had either aborted or came from infected herds, 62 (nearly 50 per cent.) gave some agglutination, although only 38 agglutinated in the dilution of 1 to 100 or more. Wall pointed out from his results that the use of the agglutination method alone is likely to lead to some errors and to many cases of uncertainty. In the main, however, as the above two papers indicate, its results are satisfactory.

Three papers dealing with the diagnosis of the disease in this country have recently appeared. The first of these is by Larson,[8] in which he concludes that the complement fixation test offers a reliable and satisfactory method of diagnosis. Another paper which is a continuation of the work started by Larson is by Hadley and Beach,[9] in which again the complement fixation reaction is used alone. A third paper is by the writer[10] in which both the agglutination and complement fixation reactions were tested.

The results of these papers are in agreement with European investigations and indicate that a reliable method of diagnosis in this disease is now available.

The perfection of these methods of diagnosis undoubtedly marks the greatest step towards the eradication of this disease which has yet been made. By their use it is possible to separate the infected from the uninfected animals. By proper methods of isolation and disinfection much can then be done towards ridding a herd of the disease. This is especially true in herds where the infection has just started.

[8] Larson, W. P., "The Complement Fixation Reaction in the Diagnosis of Contagious Abortion of Cattle," *Jour. Infect. Dis.*, Vol. 10, pp. 178–185, March, 1912.

[9] Hadley, F. B., and Beach, B. A., "The Diagnosis of Contagious Abortion in Cattle by Means of the Complement Fixation Test," Wisconsin Agric. Exper. Station, Research Bulletin No. 24, June, 1912.

[10] Surface, Frank M., "The Diagnosis of Infectious Abortion in Cattle," Ann. Rpt. Kentucky Agric. Exper. Station, 1912 (Bulletin 166), pp. 303–366, June, 1912.

In spite of the fact that the cause of this disease was discovered by Bang as early as 1896, very little progress has been made towards the perfection of a cure or a preventative. The most important contribution to this side of the subject also comes from Jensen's Laboratory and is by Dr. Halfdan Holth.[11] In an excellent contribution Holth gives many valuable observations on the growth and biology of the abortion bacilli. Many experiments dealing with the theory of immunity are also reported. The matter of most immediate interest, however, is that dealing with the artificial production of immunity. Holth clearly demonstrates that it is entirely possible to produce agglutinins and antibodies in animals treated with either living or dead cultures and with serum. Injection of living culture produces the largest amount of immune bodies and these remain in the blood for a longer period of time than with other treatments. Injection of a killed culture is the next most efficient way while the effects of an immune serum appear to be slight and transitory.

Experiments with rats and mice show that injection of either a serum or a properly prepared vaccine will protect them against an otherwise deadly dose of the abortion bacilli.

Whether these results will be borne out by experiments on cows or not is still unsettled. Experiments are under way in Denmark and other places which will settle this matter before long.

In this connection should be mentioned the excellent review by Oluf Bang[12] of the work

[11] Holth, Halfdan, "Kastningsbacillens Biologi og Immunitetsforholdene ved Sygdommen," *Maanedsskrift for Dyrlaeger*, XXII., 1911. Also "Untersuchungen über die Biologie des Abortusbacillus und die Immunitätsverhältnisse des infektiösen Abortus der Rinder," *Zeit. f. Infektionskrankheiten usw. der Haustiere*, Bd. X., 1911, 94 pp.

[12] Bang, Oluf, "Schutzimpfung gegen den infektiösen Abortus," Klimmer u. Wolff-Eisner's "Handbuch der Serumtherapie und Serumdiagnostik in der Veterinärmedzin," Leipzig, 1911, pp. 202–223.

that has been done in the attempt to protect animals against infectious abortion. Many experiments are reviewed in this article which are not to be found in the general literature of abortion. Many of these are scattered through Danish veterinary journals and many others are here published for the first time. The results of the experiments given indicate that there is some hope of producing immunity by means of vaccines or serums. There is, however, need of many long continued and carefully planned experiments to prove this. The insidious nature of the disease makes it very difficult to obtain crucial evidence. The above cited paper is an excellent summary of the work so far done in this direction.

Not the least interesting phase of the study of infectious abortion is that which has recently appeared from the laboratory of Dr. Theobald Smith.[13] In these papers Smith and Fabyan have clearly demonstrated a fact which has been overlooked by previous students of this subject, viz., that the abortion bacillus is able to cause marked pathological lesions in guinea-pigs and other laboratory animals. Further, these lesions are by no means confined to the reproductive organs, but affect in particular, the spleen, liver, bones, lungs, lymph-nodes and kidneys. The lesions are not unlike those produced by tuberculosis. In a few cases death ensued after some weeks, in others the animals appeared to recover and maintain a general good health. No external symptoms, other than a slight loss in weight, were present in the majority of cases. In some instances paralysis of the hind quarters was noted. Occasional cases of blindness and the enlargement of the lymph nodes were other symptoms.

The interest in the disease is increased by the fact pointed out by Smith and later by the U. S. Department of Agriculture[14] that the abortion bacillus occurs in the milk of infected cows and that the injection of such milk into healthy guinea-pigs will produce lesions similar to those noted above. Further, it is possible to recover the abortion bacilli from animals inoculated with such milk.

The fact that a large portion of dairy milk contains the abortion bacilli and the further fact that in cattle the most common means of infection is through the alimentary canal make it at least suggestive that this organism may be an etiological factor in certain human infections.

Frank M. Surface
Kentucky Experiment Station,
Lexington, Ky.

[13] Smith, Theobald, and Fabyan, Marshall, "Ueber die Pathogene Wirkung des Bacillus abortus Bang," *Central. f. Bakt. usw.*, I., Orig. Bd. 61, pp. 549–556, January, 1912. Fabyan, Marshall, "A Contribution to the Pathogenesis of *B. abortus* Bang," *Jour. Med. Research*, Vol. XXVI., pp. 441–489, July, 1912.

[14] Bureau of Animal Industry, U. S. Department of Agriculture, Circular No. 198, March, 1912.

SPECIAL ARTICLES

THE EFFECTS OF ALKALOIDS ON THE DEVELOPMENT OF FISH (FUNDULUS) EMBRYOS

In previous experiments it was found that a large number of neutral salts and many anesthetics, including alcohols, when applied to *Fundulus* embryos, in concentrations slightly below the fatal dose, produce abnormalities in the eyes. The most striking of these abnormalities is the presence of one median eye instead of the usual eyes, a condition known as cyclopia. In some embryos but one eye is present and is lateral, as in the normal fish, a defect designated as monophthalmia asymmetrica.

Considering the variety of the "poisons" used, one might suspect that the *Fundulus* embryo reacts to all poisons by developing defects in the eyes, provided the right concentration of the harmful substances is found. To determine this, it is not necessary to try an infinite number of concentrations of the reagent, since I found that the concentrations producing cyclopia were the highest concentrations in which the embryos could live. It is only necessary to determine the lethal dose, and then make a finely graduated series just below this limit. In this way I have tried out members of an entirely different class of substances, namely, alkaloids.

Of the alkaloids so far tried theobromine is not sufficiently soluble in sea water to affect the embryos noticeably. The effects of caffeine and theine[1] are identical. Nicotine is four times more toxic, but when used in proper concentration produces similar results ($M/400$ nicotine $= M/100$ caffeine).

The effects of these alkaloids is cumulative, *i. e.*, the greater the length of time the embryos remain in a solution, the less the concentration of the latter needed to produce a certain effect.

In the majority of the experiments, the embryos at about the four-cell stage, were placed in sea-water solutions of the alkaloids and allowed to remain thirty-six hours, then transferred to sea water.

The very constant effects of these alkaloids[2] are the enlargement of pericardium, ear and brain vesicles and cœlom, together with the suppression of the circulation. The heart may or may not beat, and may or may not contain erythrocytes. Erythrocytes are seen in the embryo, but not on the yolk sac. They are often clumped in masses of various sizes along the non-functional blood vessels. Black pigment cells migrate over the lower side of the pericardium and red pigment cells over the heart in an abnormal manner.

Primary cyclopia is extremely rare. In fact, the only cases found were two in the nicotine solutions. However, there are cases of secondary "one-eyedness" due to degeneration of one of the eyes or fusion of the eyes.

Many of the alkaloid embryos sooner or later begin to degenerate. Since degeneration occurs in other classes of experiments with *Fundulus* embryos in which the circulation is suppressed, the lack of a circulation might be considered the cause of degeneration. However, I consider this improbable, since many embryos lacking a circulation show no signs of degeneration, unless the œdema of serous cavities be considered such. The degenerative effects of alkaloids may not appear until after the period when the circulation is normally established, even though the embryos were removed from the solutions before this period. But this does not prove that degeneration is due to lack of a circulation.

One eye may degenerate before the other, but usually the degeneration is symmetrical. The degenerating eye becomes irregular in outline and finally its boundary can not be distinguished. The retinal pigment is the only part of the eye substance that remains identifiable in living specimens. In one specimen the two pigment masses moved from their position in the head and formed an attachment to the venous end of the heart.

In the stronger solutions, the cells over the whole surface of the embryo become loosened at an early stage. A process of de-differentiation occurs, and there finally remains but an irregular patch of cells, among which only the pigment cells are distinctive. In this condition the embryo may live for many days.

Similar degeneration may occur as the effect of other poisons, but seems to be more common as an effect of alkaloids. On the other hand, cyclopia is rarer in alkaloid embryos than in those treated with certain other substances. Whereas in solutions of ethyl alcohol 100 per cent. of the embryos may show primary defects in the eyes; such occurred in only about one in a thousand of the nicotine embryos. Although thousands of eggs were placed in caffeine and theine, this number is too small to exclude the possibility that cyclopia might occur as frequently as in nicotine.

Much has been said for and against the idea of the specificity of the action of various substances on embryos. The data found in the literature indicate that more qualitative and quantitative observations are needed on this subject. Organisms are not simply chemical compounds. In studying the mechanism of the effects of chemicals, the *structure* of the organisms should be especially considered; and not only the morphological structure, but

[1] Considered identical chemically.

[2] And of a number of others used since this went to press.

the chemical and physical nature of the component parts.

J. F. McClendon
U. S. Bureau of Fisheries,
Woods Hole, Mass.,
July 20, 1912

ON THE RELATIONSHIP BETWEEN THE BILATERAL ASYMMETRY OF THE UNILOCULAR FRUIT AND THE WEIGHT OF THE SEED WHICH IT PRODUCES

The problem of symmetry, radial and bilateral, is of such great interest that it can not be approached from too many angles. The purpose of the present note is to discuss on the basis of a rather extensive series of quantitative data the question: "Do bean pods with an 'odd' number of ovules produce lighter seeds than those with an even (2, 4, 6, etc.) number?" Here the "odd" or "even" character of the pod is to some extent an index of bilateral asymmetry. Pods with an odd number of ovules must have them unequally divided between the two carpellary margins which form the ventral suture, while those with an even number generally have them equally divided. Thus with respect to the distribution of ovules, pods with an odd number must be bilaterally asymmetrical; those with an even number are generally bilaterally symmetrical.

The results which led up to the present study were the discovery of an intra-individual selective elimination of ovaries with a larger number of "odd" locules in *Staphylea*[1] and the demonstration of a usually lower fertility and fecundity in "odd" pods of *Phaseolus*.[2]

[1] For literature, see: "The Selective Elimination of Organs," Science, N. S., XXXII., 519–528, 1910; "On the Selective Elimination occurring during the Development of the Fruit of *Staphylea*," *Biometrika*, VII., 452–504, 1910; "Further Observations on the Selective Elimination of Organs in *Staphylea*," *Zeitschrift f. Ind. Abst.- u. Vererbungsl.*, V., 273–288, 1911; "The Measurement of Natural Selection," *Pop. Sci. Mo.*, LXXVIII., 521–538, 1911.

[2] "On the Relationship between Bilateral Asymmetry and Fertility and Fecundity." In press in Roux's *Archiv f. Entwickelungsmechanik*.

Among the series of individually weighed bean seeds gathered for a study of the pure line problem are five in which the number of ovules in the pod from which the seed was taken is recorded. These series (designated by key letters) are:

L. Golden Wax. Grown at Lawrence, Kansas, 1906. 2,861 seeds.

LL. Golden Wax. Plants the offspring of the L series, grown at Lawrence, Kansas, 1907. 3,947 seeds.

GG. Burpee's Stringless. Grown at the Missouri Botanical Garden, 1907. 8,364 seeds.

H. Navy. Grown near Sharpsburg, Ohio, 1907. 5,778 seeds.

D. Navy. Another series, grown under very different conditions near Sharpsburg, Ohio, 1907. 2,362 seeds.

The material is, therefore, rather extensive and diversified. Two methods of analysis are possible. (*a*) The pods may be merely classified as "odd" and "even" and the mean weight of the seeds produced by each kind determined. (*b*) A regression equation can be fitted to the whole data and the weighted mean deviation of the empirical means from the theoretical means determined for either "odd" or "even" pods.

Let o = number of ovules per pod, w = weight of seed in units of .025 grams. Then correlations and regression straight line equations are:[3]

Series	Correlation	Regression Equation
L	$r = -.0401$	$w = 16.4645 - .1597\ o$
LL	$r = +.0586$	$w = 13.0281 + .2060\ o$
GG	$r = +.0109$	$w = 17.3881 + .0354\ o$
NH	$r = -.1410$	$w = 11.0961 - .2806\ o$
ND	$r = -.1227$	$w = 8.5554 - .2583\ o$

The correlations are in all cases low. Testing the influence of the "odd" (asymmetrical) character of the pod upon the weight of the seed by the weighted mean deviation (regarding signs) of the average weights of seeds produced by odd pods from the theoretical means calculated from these equations as well

[3] Data from which all the constants given here may be checked will be eventually published for another purpose.

as by the method of comparison of averages for all "odd" and "even" we find:

Series	Regression Line Test	Difference in Means
L	—.0137	—.0030
LL	—.0768	—.2506
GG	—.0164	—.0329
NH	—.0597	—.0338
ND	—.0777	—.1754
Unweighted averages	—.0489	—.0991

By both methods all the deviations are negative in sign, though of a low order of magnitude. Apparently, bean seeds produced in pods with an odd number of ovules are about .0025 gram lighter than those in pods with an even number. Asymmetrical pods are, therefore, physiologically less efficient than symmetrical. To be sure the relationship is a very delicate one; the individual series show considerable fluctuations. Many more observations are desirable, but the duplication of a series of over 23,000 individual weighings with records of the characteristics of the pods from which the seed was derived is not easily carried out. The findings are consistent throughout within the limits of error. They confirm from an entirely different angle conclusions drawn from studies of selective elimination and of fertility and fecundity. It seems worth while, therefore, to place on record the results for the available data.

J. Arthur Harris
Cold Spring Harbor, N. Y.

HEAT CONDUCTIVITY OF CRYSTALS

For several years one of the experiments in our course in physical crystallography has been a qualitative determination of the conductivity of heat in crystals by the Senarmont method described by Groth, "Physikalische Krystallographie," page 178. The Senarmont apparatus is used for these tests. It consists of a stage for supporting the crystal, so arranged that a spring presses it up against the contact point of the conductor. The latter is bent at right angles and may be heated at the other end by a flame. Results were quite unsatisfactory because when the point, resting on the paraffined surface of the crystal, became heated it radiated sufficient heat to melt the paraffine and the figure, which might have been obtained by heat conducted through the crystal, was destroyed. Since the heat was radiated equally in all directions a circle in the paraffine resulted. A modification of this method gives much better results.

A plate of the mineral, for example, gypsum, about 1–2 mm. thick is dipped in melted paraffine until a thin even coat is formed on one side. The plate is then placed on the stage of the instrument with the paraffined surface down, but is insulated from the stage by strips of asbestos under the edges. The point of the conducting wire rests in a depression in the upper unparaffined surface. In this way, when the heat is conducted along the wire to the crystal it must actually be transmitted through the gypsum before it can melt the paraffine. A very sharply defined ellipse will be noted in the paraffine and this is clearly due to differences in conductivity of the gypsum in different directions and not to radiation from the wire.

R. W. Clark
Mineralogical Laboratory,
University of Michigan,
May 30, 1912

SOME CURIOUS CASES OF SELECTIVE REFLECTION IN ULTRAVIOLET LIGHT

Professor Woods, of Johns Hopkins University, has found that some white flowers, when photographed in ultraviolet light, appeared as black or nearly so. This fact led the writer to examine the behavior, in such circumstances, of a number of alkaloids, glucosids and other vegetable immediate principles he happened to have on hand. The result is shown on the two accompanying figures. Photograph number I. was taken with an ordinary objective. Number II. is a photograph of the very same substances taken with a quartz convex meniscus, silvered on both faces and completely opaque to visible light. The 24 substances had been previously powdered and somewhat compressed into their respective boxes. As the ordinary photograph shows, they were, with but one exception (berberin) perfectly white. Photograph number II. shows that, if our eye were sensitive to ultraviolet light, about two thirds of these white substances, when immerged in such light, would appear to us as black or dark gray. As a rule inorganic compounds do not compounds reflect ultraviolet light about as they reflect ordinary light.

The writer was unable to find any constant relation between the chemical constitution or

seem to behave in such an extraordinary manner. Excepting zinc oxyde which, as Professor Wood has shown, powerfully absorbs ultraviolet light, and bismuth sub-nitrate which, as the writer and Professor Tristan have found, reflects but little more ultraviolet light than zinc oxide, most inorganic physical properties of the 24 substances and their selective reflection for ultraviolet light.

The tremendous differences shown on the two photographs will probably one day find some application to analytical chemistry.

Gustave Michaud
Costa Rica State College

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THE ALLEGHENY OBSERVATORY IN ITS RELATION TO ASTRONOMY[1]

When I last visited the Allegheny Observatory, in 1869, I found very different conditions from those that prevail to-day. As a boy, I had learned that Pittsburgh was at the junction of the Allegheny and Monongahela Rivers, and I was glad to verify it by actual inspection from the door of the observatory. To-day these rivers are not in sight. The little thirteen-inch telescope appears to have attained dimensions and to have acquired appliances beyond our dreams in those days. In one respect is the observatory unchanged. I find a young and enthusiastic director, full of new ideas and, I hope, aiming to make this observatory the greatest in the world. My good friend Langley was then thirty-four years old. His work on the sun, continued through his life, was in its infancy. He tried to persuade us that the smoke hanging over Pittsburgh was especially advantageous for his line of work, since it cut off the irregularities due to the heat of the sun when the sky is clear. Within limits, this is true.

The early history of the Allegheny Observatory is unique, and in some respects stormy. The first director became obsessed with the idea that the telescope must be preserved, but not used. This view he maintained with the aid of a shotgun. He became insane, and wrote a poem. Far be it from me to suggest any connection between these two facts. In this poem, he predicted that the object glass of the telescope would be stolen. Strangely enough,

[1] An address delivered at the dedication of the new Allegheny Observatory, August 28, 1912.

this prediction came true, and more strangely still, in spite of this prediction, it was proved conclusively that he had nothing to do with the theft. The object glass was carried off and held for ransom by persons who greatly overestimated its value. Langley gave a most interesting account of his experiences with the thieves. He was supported by the trustees of the observatory in maintaining that not a cent should be paid unless the thief could be punished, otherwise no large lens in the country would be safe. Finally he met the thief by appointment, one evening, and as they walked up and down a wooded path, the thief remarked, "You are a gentleman, and I am a gentleman; we must trust one another." Finally, the lens was returned uninjured, without ransom.

Langley's invention of the bolometer opened a line of research which has continued to the present time. He displayed consummate skill and ingenuity in its development, and extraordinary patience in overcoming the numerous difficulties which presented themselves. Even in those early days he was deeply interested in the problems of artificial flight. We were often together in the woods or mountains and whenever he saw a hawk, or other large bird soaring, he would stop and watch it, saying, "Some day we shall do that." His discovery of the internal work of the wind was one whose importance does not seem yet to be appreciated. It still seems possible that practical results may be obtained from it. The credit for the invention of the aeroplane is due, in a large measure, to him, and he was bitterly hurt at his treatment by the public press after the destruction of his first aeroplane. Later experience shows that another trial might have proved an entire success.

My acquaintance with his successor, Keeler, was much less intimate, but close enough to recognize his charming disposition and rare talents. Astronomy suffered a heavy loss in his early death. In his work here, and on Mount Hamilton, he has left among others two researches with the spectroscope which have become classical. First, the brilliant proof that the rings of Saturn are composed of minute portions revolving independently around the planet. Secondly, a determination of the motion in the line of sight of gaseous nebulæ. This appears to be the best solution yet found of this problem. It is remarkable that no one has repeated and continued it. Keeler measured only ten of the two hundred nebulæ now known to be gaseous.

The work of Wadsworth was more in preparation than in obtaining results, while that of Acting-Director Brashear has been overshadowed by an enthusiasm which has not only rendered this new observatory possible, but will be of the greatest value to it in the future, and inspires us all to renewed efforts by his unflagging zeal.

The present director, Professor Schlesinger, can give you a better description of his work than I can. But as I fear that he may not do justice to its quality, a brief account of it may not be out of place here. Half a century ago, the character of the work done by astronomers was very different from that undertaken at the present time. It then consisted almost entirely in a study of the positions and motions of the heavenly bodies. In fact, if an astronomer had a large equatorial telescope, he generally devoted himself to measuring the relative positions of the components of double stars, and if he had a meridian circle, he measured the positions of large numbers of stars, and determined day by day the exact time. At the larger observatories the position of the moon and other objects in the solar system were determined. A few far-seeing men of genius like Argelander, the Herschels and the Bonds undertook other lines of work, but the last half of the nineteenth century saw the birth of a new science, astrophysics, which relates to other properties of the stars, such as their brightness, size, color and spectrum. Astronomy may, therefore, be divided into two classes, the astronomy of position and astrophysics, which Langley called the old and the new astronomy. Two years ago, forty of the leading astronomers of Europe visited this country to attend the meeting of the Solar Union, at the Mount Wilson Observatory, in California. On the way, many of them attended the meeting in Cambridge of the Astronomical and Astrophysical Society of America, now in session here. One of the most eminent of these astronomers, while complimenting us highly on American work in astrophysics, pointed out that of the forty-eight papers read at the meeting, but one related to astronomy of position. You are fortunate in having as director of the Allegheny Observatory an astronomer who has distinguished himself in both departments of the science. A very interesting problem in astronomy of position is a curious motion of the earth by which the latitude of any given point is continually changing by a small amount. If we found the average position of the North Pole and built a circular fence around it seventy feet in diameter, the pole would wander about the enclosed space, describing an irregular spiral, but never going outside of it. Last year the pole appears to have been nearer the fence than at any time during the last quarter of a century, or since the discovery of this motion. A number of stations are now maintained by the International Geodetic Association, at which continuous measures are made of the position of the pole. The accuracy of these measures is such that its position is known within one or two feet. For four years Professor Schlesinger took part in these measures at the station in Ukiah, California. He thus familiarized himself with some of the most accurate methods of measurement of position known.

One of the most important problems before astronomers at the present time is to determine the distances of the stars. The only direct method of finding the distance of an inaccessible object is to measure the change in its apparent position as seen from different points. Fortunately, we can apply this method to the stars, since the earth is more than ninety million miles from the sun, and by its revolution around the latter its position is changed by nearly two hundred million miles. It is quite impossible for the mind of man to conceive of such a distance, but vast as it is, it is almost inappreciable compared with the distance of the stars. Few of them are less than a million times as distant as the sun, and the greater portion of them are probably thousands of times as distant as the nearest. The apparent change in position of the nearest star, as the earth moves two hundred million miles, would equal the height of a man at a distance of two hundred miles. In other words, the problem is like measuring the height of a man two hundred miles away. Various methods have been tried, but the most accurate of all appears to be that employed by Professor Schlesinger. He finds the height of the man with an uncertainty of only one inch! The method he used, when he was at the Yerkes Observatory, consisted in taking photographs with the forty-inch refractor of that institution, the largest telescope of its kind in the world. By using plates sensitive to the yellow rays, he obtained very minute images of the stars, which could be measured with the greatest accuracy. The results for a large number of stars measured in this way indicated a probable error of only a hundredth of a second of arc.

The criticism that, in America, we were not doing our share of the study of the position of the stars, seemed to be a just one. Accordingly, as president of the Astronomical and Astrophysical Society of America, I appointed a committee to remedy this defect as far as possible, and selected Professor Schlesinger as its chairman. Some of the results so far obtained will be announced at the present meeting of the society. Besides the work already described, admirable results in astrophysics have recently been obtained at the Allegheny Observatory by the director, in measuring the motion of the stars in the line of sight, a problem now receiving more attention than any other in many of the principal observatories of the world. Of this problem, it is sufficient to say that to obtain results of the accuracy attained elsewhere, it is necessary to have a telescope of the largest size, a spectroscope of the most approved form, and measures and reductions of the photographs of the greatest possible accuracy.

You will thus see that, as already stated, you have secured an astronomer and placed him in charge of your observatory, who has shown great skill and efficiency in both the old and the new departments of astronomical research. You have before you a beautiful and suitable building and an equipment of instruments of the highest grade. All of those conditions are most favorable, but the future success will now depend largely on you. Allegheny is doubtless a very different place intellectually from what it was when Langley was here, but one of his principal sources of discouragement was the lack of interest in his work, and a failure to appreciate his success by his friends, with a few notable exceptions. I hope that you will follow the work of the Allegheny Observatory closely, and I am sure that you will find the results of interest and value. A large force of observers and computers is needed to derive the best results from an equipment such as is collected here. The number of officers at several of the largest observatories is thirty or forty, and such a force is required to complete in a reasonable time some of the great problems which now form the most important contribution which can be made to astronomy. For example, suppose that an astronomer has developed by long and careful study the best method of attaining a certain result with an instrument costing many thousands of dollars. He can almost always instruct a younger and less able man than himself to repeat his work on other stars. A research can thus be extended, at small additional expense, to hundreds or perhaps thousands of stars, until the entire available time of the instrument is occupied. In visual observations of the stars, this time is greatly restricted by clouds, twilight, moonlight and other causes, while a photograph exposed for a few minutes may furnish material for weeks of study. After a photograph is measured, there is often a long and laborious computation to be undertaken, which can be carried on by unskilled computers after they have been taught the exact method. The results are of no value unless they are made known to the world by publication. This involves laborious copying, arranging material in suitable form, reading of proof and other work involved in publication, in addition to the actual cost of printing. It is evidently very poor economy to establish an extensive plant, and then fail to work it to its full capacity. A steamer which should be idle for ten or eleven months every year would prove a very poor investment. In astronomy, increasing returns constitute the rule and not the exception, while the methods of securing the maximum efficiency by the principles of "scientific management" may be as successful in an observatory as in an industrial establishment.

An illustration of my meaning is presented by the photometric work at Harvard. In 1879 an instrument was constructed for measuring the light of the bright stars, with telescopes two inches in diameter. With this, during the next three years, a hundred thousand measures were made of four thousand stars, mainly visible to the naked eye. When people asked me if we had the largest telescope in the world, I would answer, "No, but we have the smallest that is doing useful work." Encouraged by the success attained, a second similar instrument was constructed with telescopes of four inches aperture. Since 1882 over a million measures have been made of nearly fifty thousand stars. Three times it has been sent to South America to measure the southern stars, and it is now on its way to South Africa, loaned to an English astronomer. To study still fainter stars a twelve-inch telescope has been mounted, and with this since 1892 I have made seven hundred thousand measures of about forty thousand stars. The results fill ten of the quarto volumes of the *Annals* of the observatory, and furnish a standard scale of magnitude from the first to the twelfth magnitude for stars from the north to the south pole.

An excellent example of organization is furnished by the work of the International Astronomical Society. The great astronomer Argelander proposed to determine the exact places of a hundred thousand northern stars. Seventeen observatories took part, including two in America, Harvard and Albany. In extending the work to the southern stars, Harvard again took a zone. Each zone occupied an observer and a corps of assistants for nearly a quarter of a century. The results of both fill half a dozen volumes of the *Annals* and the cost in salaries alone was about two hundred thousand dollars.

May we see some of the great problems in astronomy solved at the Allegheny Observatory better than ever before, and the work repeated on star after star until the entire field has been successfully covered.

Edward Charles Pickering
Harvard College Observatory

THE RESPONSIBILITIES OF AN OBSERVATORY STAFF[1]

It falls to me in these dedicatory exercises to say a few words on behalf of the observatory staff, into whose keeping these fine instruments are for the time being placed. You may be sure that we have given much thought to deciding how we might best fulfill this trust, and it is natural that the same question should be a prominent one in the minds of all those who are interested in the welfare of this institution. We are doubtless all agreed that our observatory has not been erected for the purpose of enhancing the reputation of any individual or individuals, nor to enhance the reputation of the observatory itself, nor of the university of which the observatory is the astronomical department. These things are much to be desired in themselves, and we hope that they may come to pass; but if they do come to pass it must be only incidentally, and nothing of this kind must be allowed to obscure the goal toward which we are striving; namely, to add as much as we can to the progress of our science; or, to use the words that were often in the mouth of the

[1] An address delivered at the dedication of the new Allegheny Observatory, August 28, 1912.

first chairman of our observatory committee, "to push forward the frontier of human knowledge."

In the minds of many whose interest in astronomy is general rather than special, we often find the belief that it is the principal business of the astronomer to make discoveries. It is true that there is hardly anything more striking that the astronomer can do than to bring to the attention of the world a new comet, a temporary star, or the like. But valuable as such discoveries are, they do not constitute the kind of work that will most rapidly push forward the frontier of human knowledge. I would, if I might, place an inscription above the door of this observatory and would call to it the attention of each new member of our staff, "Abandon hope of making discoveries, all ye who enter here." This view may seem a radical one to part of my audience, but I am sure that it will meet with ready sympathy among those astronomers here present who have had occasion to give thought to this subject. Some years ago, Professor Cattell, the editor of Science, asked ten of our leading astronomers to set down in the order of their preference the names of those living Americans who had contributed most to the progress of astronomy. One result of this ballot was very remarkable; it was found that the voters had without exception put the same name at the head of their lists—that of Simon Newcomb. This high place in the esteem of his colleagues was reached by setting on foot and directing the exceedingly laborious computations that would enable us to predict the situations of the sun, moon, planets and some of the fixed stars, with greater accuracy than had hitherto been the case; or, in other words, by following out with greater thoroughness, the consequences of the law of gravitation within the solar system. To this, the principal work of his life, Newcomb continued to add other important investigations up to the day of his death; but throughout his long and fruitful career we find no record of a discovery. Be it well understood that I am using this word with its narrower meaning, and not in the sense that would permit us to speak of Kirchhoff as having discovered the principle of spectrum analysis, or of Langley as having discovered a method of mapping the entire spectrum of the sun.

Let me give one other illustration of what work it is that astronomers themselves deem to be the best. Near the little village of Nyack there lives in modest retirement upon the farm of his fathers and of his own boyhood, George William Hill. Although he is perhaps the greatest genius that this country has as yet borne, it is safe to say that not one person in a thousand, even among people of education, is familiar with his name, much less with his work. But among astronomers, both abroad and at home (possibly more abroad than at home), he is recognized as being one of a very few to whom astronomy of the present day owes most. Here again discoveries form no part of this notable career; and in fact so far as records go, Hill may never have used a telescope. His greatest work is in connection with periodic orbits, the best method yet devised for handling the problem of three bodies under certain restrictions.

You are not getting the impression, I trust, that I wish to belittle the work of discovery. I am merely trying to get the bearing of such work so far as it affects the responsibilties of an observatory staff, at whose disposal have been placed instruments of the first rank. You must first catch your comet before you can make comet investigations, and so with asteroids, double stars and spectroscopic binaries.

Statistical investigations concerning all four of these classes of bodies have recently been made; they constitute additions of the most desirable kind to our stock of knowledge, and have done much to indicate in what directions further additions are to be sought. Apart from all this, if the discovery of a comet (for example) were not otherwise useful, it would frequently justify itself by calling attention to men of promise. It was in this way that the astronomical world has come to have the benefit of the extraordinary talents of Edward Emerson Barnard. With a little telescope purchased out of the meager earnings of his youth, he discovered in rapid succession a surprising number of faint comets. The attention thus attracted to him soon resulted in an appointment at the Lick Observatory, and later one at the Yerkes Observatory, so that he has had access to some of the most powerful instruments in the world. He has used these instruments to excellent purpose and with a diligence that has rarely been equalled; but it is significant that in the past twenty years he has made no further discoveries. In a case like this it would be more to the point to speak of the comet as having discovered the man, than of the man as having discovered the comet.

We are often told that an astronomer pointing his telescope more or less at random to the sky and faithfully recording what he sees or photographs, is bound to add something to our fund of knowledge. While this is true, promiscuous observing is to be encouraged only if nothing else is possible, and is surely never to be encouraged within an observatory. The fact is that astronomy of to-day demands answers to definite questions; the astronomer who goes to his telescope without having one of these questions in mind is at least partially wasting his time. In other words an observatory staff should regard their profession as a branch of engineering, in which the problems to be solved are quite as definite as those, for example, that confront the civil engineer. If this seems to you to be a somewhat dry view to take of so beautiful a subject as astronomy, I would remind you that none save engineers are especially interested in the plans and specifications for a bridge, but that all of us can take delight in the finished structure, either for its utility or its beauty. In the same way the methods employed by the astronomer are almost always of very special interest, while the results of his work appeal to us all as educated men and women. How long will the sun continue to be sensibly as bright and as hot as it is now? How does our sun compare in size and glory with other stars? How comes it that some stars are double, while others (our sun among them) are single? How are the stars distributed in space? What causes some stars to vary in brightness? These are some of the questions to which astronomers are seeking the answers, and the results of these inquiries will surely interest you as deeply as they do the astronomer himself.

Let me now state briefly what specific use we intend to make of our various instruments. Under the north dome is the Keeler memorial reflector, having an aperture of thirty inches. This telescope and the Mellon spectroscope attached to it have been in constant use during the past six years in the prosecution of a single research, the determination of the orbits of spectroscopic binaries. This work we shall continue as long as it remains profitable to do so. Under the same dome is a vertical or tower telescope of nine inches aperture and twenty-nine feet focal length. This is "fed" by a cœlostat mirror on the mounting for the Keeler reflector, and attached to the telescope is a powerful solar spectrograph, the gift of Mr. H. K. Porter. With these we are taking part in the spectroscopic determination of the solar rotation, a project that was set on foot at the last meeting of the International Solar Union, and in which six observatories, in this country and abroad, are cooperating.

Under the southeast dome is the thirteen-inch visual refractor that formed the nucleus around which the old observatory was built. Once the third largest telescope in the world, it has now become the third largest in our observatory. This telescope we now use chiefly for the instruction of the public; with the lecture hall below it (used on cloudy evenings) it forms a public observatory, the privileges of which are freely offered to the people of Pittsburgh. So eagerly has this offer been accepted, that two years ago we found it expedient and possible to extend this work, and to pledge ourselves to continue it in perpetuity.

Attached to the thirteen-inch refractor is a four-inch camera, used to determine the brightness of stars by the extra-focal method. The observing program is made up chiefly of stars that we are observing at the same time with the spectrograph.

In one of the basement rooms on the north side of the building a ten-inch photographic telescope is mounted in a fixed position on an inclined pier and directed toward the north pole of the heavens. The work with this instrument is of an experimental character. If its outcome should be favorable we hope to undertake, probably in cooperation with the Harvard College Observatory, the compilation of a catalogue of faint stars by entirely new methods.

At the west end of our building is a four-inch transit instrument with which we are still maintaining the extensive time-service installed by Langley in 1869. As auxiliaries to this instrument we have three second-pendulum clocks. One of these is a Riefler clock maintained under constant pressure and temperature, and this proves to be a time-piece of unusually accurate performance.

Lastly we come to the Thaw memorial telescope, under whose dome we are assembled this afternoon. Last summer when we fixed the date for this dedication, we thought that this telescope would be quite complete by to-day; but it appears that at least another year must elapse before the objective can be ready. This is due to the difficulty of securing a suitable disk of flint glass, the crown disk having been delivered some months ago. The aperture of the telescope is to be not less than thirty inches, and unlike most other refractors of the largest size, it is to be primarily a photographic instrument. A twelve-inch correcting lens is to be provided; it will be a matter of only a few seconds to put it into the optical axis, thus changing the color curve into one that will be suitable for visual observations. The mounting has all those appurtenances (and no other) that modern practise has shown to be desirable. Throughout its design and construction, efficiency for astrometric work was the chief object in view.

With the Thaw telescope we contemplate an attack upon three problems; first, the accurate determination of the distances of many stars. How extensively we shall go into this work will depend upon the activities of certain other observatories that have declared similar intentions. But the need of such determinations is one of the most pressing in astronomy and it is likely that the telescope before us can be profitably occupied in this work for many years to come. Secondly, we owe it to our successors of perhaps a hundred years hence to determine with great accuracy the relative places of stars that form globular clusters. It is only in this way that we shall ever be able to say what the motions within these clusters are; and this in turn will go far toward telling us what these objects themselves are, and what place they occupy in the universe of stars. A third research that we contemplate is the determination of the brightness of faint stars by means of extra-focal images, or otherwise expanded star disks. This method for determining stellar magnitudes is surpassed in accuracy only by the selenium photometer, which is however not applicable to faint stars.

These are the things that we have in mind, but we reserve the right to alter these intentions as soon and as often as circumstances may demand. I should not wish to commit myself, much less any other man, to an unalterable routine of work. But I do wish that it were in my power to commit the present staff and its successors to the policy of doing that thing which is most in need of attention, within the limits set by our resources and equipment, both personal and instrumental. If we do not succeed in contributing our fair share to the progress of our science, I think it will not be because we have not tried; and I believe I can make this promise for those who are to come after us, as well as for ourselves. For it would be a strange thing if the devotion that has been lavished upon the Allegheny Observatory by William Thaw and his sons, by Langley, Keeler, Wadsworth and Brashear—it would be a strange thing, I say, if the example of such devotion should ever cease to be a compelling incentive to any who may have the privilege of working within these walls, and if the tree that these men have planted and nourished should cease to bear fruit for many a season to come.

Frank Schlesinger
Allegheny Observatory

M. HENRI POINCARÉ

The city of Paris is commonly regarded as the greatest mathematical center of the world, and Henri Poincaré stood for a number of years at the head of the Paris mathematicians. He was a mathematician in the broadest as well as in the deepest sense of this term. He started as an engineer in 1879, but soon thereafter he entered upon his life work as university instructor, first at Caen in December, 1879, and afterwards at Paris from October, 1881, until his death on July 17, 1912. His positions in the University of Paris were as follows: Maître de conferences d'analyse, chargé du cours de mécanique physique et expérimentale; professeur de physique mathématique et de calcul des probabilités, and professeur d'astronomie mathématique et de mécanique céleste.

He was born at Nancy, April 29, 1854, and was educated successively at the Lycée de Nancy, l'École Polytechnique and at l'Ecole nationale supérieure des mines, receiving his doctor's degree from the University of Paris in 1879. He was a very bright student and received first rank at the entrance examination of l'Ecole Polytechnique. At the early age of 32 he was elected as a member of l'Académie des Sciences, and for this occasion he prepared, in 1884, a statement entitled "Notice sur les travaux scientifiques de M. Henri Poincaré."

Although this "Notice" was written less than five years after Poincaré had begun the publication of his researches, it reviews a large number of his published articles along the following three lines: (1) Differential equations, (2) General theory of functions, (3) Arithmetic or the theory of numbers. He emphasizes the fact that he did not pursue his researches in these three directions independently of each other, but that the results obtained along these various lines threw light on each other, and that his work along each one of them was greatly aided by the work along the other lines.

The breadth of scholarship exhibited by Poincaré in his early writings and his great ability to observe relations between apparently widely different subjects became still more pronounced as he grew older, but we observe even at this early date a mind of very broad sympathies and of extraordinary ability to generalize. His principal writings may be classed under the following four headings: pure mathematics, analytic and celestial mechanics, mathematical physics, and the philosophy of science.

In 1909 Emile Borel published, in the journal called *La Revue du Mois,* an article on the method of Poincaré. Parts of this were translated for the first article in the *Bulletin of the Calcutta Mathematical Society.* In view of the great importance of the method of work, we quote parts of this translation.

> The method of Poincaré is essentially active and constructive. He approaches a question, acquaints himself with its present condition without being much concerned about its history, finds out immediately the new analytical formulas by which the question can be advanced, deduces hastily the essential results, and then passes to another question. After having finished the writing of a memoir, he is sure to pause for a while, and to think out how the exposition could be improved; but he would not, for a single instance, indulge in the idea of devoting several days to didactic work. Those days could be better utilized in exploring new regions.
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> All this is not specially applicable to mathematics. Let us examine more closely the mechanism made use of for discovery. The essential feature of that mechanism is, as we have already pointed out, the construction of new formulas. It is not useless that some stress is laid on this point, for this constructive power is the essential trait of the genius of Poincaré. The non-mathematical readers can be made to understand all this by means of a comparison. They know what arithmetical calculation is, and are often led to believe that mathematicians are in the habit of making interminable additions, multiplications, etc., and also extractions of cube roots.
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> In reality, arithmetical operations are unique combinations of integral numbers formed of units which are all equal to one another. These operations can be compared to the construction of regular walls by means of bricks of uniform sizes. The work requires only some patience and a little care. On the contrary, analytical operations make use of extremely numerous materials and their variety is comparable to those of structures, where stone, marble, wood, iron, etc., are used. These operations are as different from each other as cuirassé is from a Gothic church. They have also with the architectural constructions this in common, that an impression of beauty is produced by the simplicity and elegance of the essential lines, without exhibiting any of the effort by means of which the result has been obtained.

Poincaré was a great pioneer, boldly entering into unexplored regions and noting some of the most important objective points and then leaving to others the details of organization. In the words of Borel he was more of a conqueror than a colonizer, and he attached little importance to conceptions which can not be realized in a concrete form. In this respect he may be compared with men of action; his method of work was too active to leave much room for such reflections as do not lead to concrete results.

On January 28, 1909, Poincaré was received as member of l'Académie Française, and on this occasion M. Masson, Directeur de l'Académie, delivered an address in which he entered into many details in Poincaré's career. A translation of a part of this address appeared in the *Popular Science Monthly,* September, 1909, page 267. A sketch of Poincaré's career may also be found in the *Independent,* October 5, 1911, under the general title of "Twelve Major Prophets of To-day." An elementary article by Poincaré on the foundations of geometry appeared in the *Monist,* October, 1898, and a number of his other articles have been translated into English from foreign journals.

In 1909 Ernest Lebon published, in his series entitled "Savants du Jour," a little volume on Henri Poincaré. This volume contains a list of his 436 different publications. The largest number of articles classed under one heading is 98, under the general heading of Pure Analysis. The number of his other articles in pure mathematics at this time was 46, 23 being classed under each of the two headings, analysis applied to arithmetic and analysis applied to geometry. From this it appears that only about one third of Poincaré's writings were devoted to pure mathematics.

Poincaré won great fame in connection with his prize memoir relating to the problem of three bodies. In 1885 King Oscar II. of Sweden offered a prize for the solution of a question in reference to this general problem, and one half of this prize was awarded to Poincaré for his article entitled, "Sur le problème des trois corps et les équations de la dynamique," published in the *Acta Mathematica* in 1890. In the *Bibliotheca Mathematica* for 1904, page 198, Eneström calls attention to the interesting fact that the copy of this memoir for which the prize had been actually awarded contained a serious error, and that the given published article was really prepared for the press after the prize had been awarded.

Among the other prizes received by Poincaré we mention the gold medal of the Royal Astronomical Society of London, the Sylvester medal of the Royal Society of London, the Bolyai prize of the Hungarian Academy of Sciences, and the Lobatchefsky gold medal of the Kasan Mathematical Physics Society. In addition to these foreign prizes Poincaré received two prizes from the Paris Academy and a gold medal from the French Association for the Advancement of Science. He received an honorary doctor's degree from each of the following universities: Cambridge, Christiania, Oxford, Glasgow, Brussels and Stockholm.

To those who would like to establish a connection between the university athlete and intellectual greatness, between physical powers and the intellectual giant, Poincaré was a decided disappointment. He was only about 5 feet 5 inches in height, was somewhat stooped, at least in the latter part of his life, and his weight was about 154 pounds. Even as a child he was rather weak and did not generally engage in the rougher sports of the boys of his age. He cared little for politics and achieved his greatness solely through his scholarly services. When he entered the French Academy he was told that he was born a mathematician and would die a mathematician. He had, however, the good fortune to live in a country where mathematical attainments are held in high esteem even by the general public.

As evidence of the high popular regard for Poincaré we may mention the fact that the French Ambassador occupied the chair last May when Poincaré gave the first lecture of a series of four at the University of London. The account of Poincaré's funeral which appeared in Science, August 9, 1912, furnishes further evidence along this line. On this occasion M. Jules Clarétie spoke as follows, according to *Nature* of July 25:

In the name of the French Academy, I have the honor of saluting Henri Poincaré on behalf of a company of which he was justly one of the most illustrious members. When his colleagues called him, not yet thirty-two years of age, to take his place amongst us, it was a poet that this mathematician, this geometer, this philosopher, this poet of the universe, succeeded. And, from the first day, we were conquered by the simple and limpid eloquence of this master writer, who, knowing everything, verifying everything, illuminated with his definitions, animated with his observations and guided with his counsels our researches, the study of our language.

It is not to-day, nor is it here, that one must study the work of this great man, who, scarcely full-grown, had already at one bound mounted to the summits. One might say, in many and eloquent tones, how much the country owes to this son of the borders of Lorraine, to this child of Nancy, who has shed luster upon the whole of France. Before his grave the French Academy can only express its sorrow, and deplore the loss of a great seeker after truth, that stopped all too soon in the midst of his work. He would be a bold man who would assess the worth of a scholar. In celebrating his fame, we can only do homage to a philosopher whose thoughts will have so fertile, so profound an action on the new generations.

Passion for scientific truth did not suffice for him, he loved literary beauty, and this incomparable mathematician was a strong supporter of good writing, of those humanities which for so long have guided the French genius along a right and safe road. One might hear him, when the dictionary was under discussion, ask about the origin, and, as it were, the titles of nobility of words. This modern, who stimulated contemporary life by his discoveries and his calculations, defended with boldness the heritage of our ancestors. He knew that the French language is itself a country, and, against every perilous invasion, this soldier of sound speech stood firmly at the frontier.

While it would be futile to try to give an account of the mathematical work of Poincaré in such a hasty sketch, yet it seems hardly appropriate to omit entirely the things which were dearest to him. One of the earliest problems which he attacked was the study of linear differential equations with rational or algebraic coefficients. This study led him to the discovery of new functions which may be regarded as generalizations of elliptic and of modular functions. These functions were characterized by the property that they are invariant under certain linear transformations. He was thus led to the study of various groups of transformations, and in his "Notice," to which we referred above, he remarks that there is a theory which has been equally useful to him in all his researches, namely, that of the groups formed by linear substitutions. In fact, these substitutions play a preponderant rôle in the study of linear equations and in that of arithmetic forms. It is to this circumstance that one ought to attribute the interrelations, often unexpected, between the theory of numbers and the theory of Fuchsian functions, theories which, moreover, do not at first appear to have any point of contact.

He pointed out relations between the theory of complex numbers and the theory of continuous groups, and thus he threw new light on these far-reaching subjects. The theory of the solution of systems of an infinite number of linear equations with an infinite number of unknowns is largely due to Poincaré. He was the first to establish definite criteria of convergence in reference to the infinite determinants employed by the American astronomer, G. W. Hill, with so much success. It should, however, be observed that infinite determinants had been studied earlier by E. Fürstenau and T. Kötteritzsch, and that these determinants should not be accredited to G. W. Hill, as is sometimes done.

Poincaré wrote a number of books especially on mathematical physics, but the three books which are perhaps the most commonly known deal with philosophical questions and bear the following titles, respectively: "La Science et l'Hypothèse," "La Valeur de la Science," and "Science et Method." In regard to the first of these, the Director of the French Academy said at the time when Poincaré entered this academy: "By the sale of 16,000 copies of 'La Science et l'Hypothèse' you have increased your personality (personnel) ten-fold."

He was fond of traveling and many Americans recall his visit to the St. Louis Exposition, in 1904, where he delivered an address entitled, "The Present and the Future of Mathematical Physics." This address was translated for the *Bulletin of the American Mathematical Society* by J. W. Young, and published in the February, 1906, number of this journal. Poincaré visited all the countries of Europe and also some of the countries of Africa. He was married and had four children—three daughters and a son.

The great mainspring of Poincaré's activity was seeking the truth. This made his life both simple and beautiful. Seeking the truth implies an open acknowledgment of ignorance. In fact, one of the strongest mathematical methods consists of putting an x for the unknown; but how could we put an x for the unknown unless we were willing to admit that we are ignorant in regard to this fact. Every one who has worked in elementary algebra knows that much is frequently gained by admitting our ignorance and by calling some particular ignorance x and another particular ignorance y, etc. Even in his mature years Poincaré could honestly ask the question "La terre tourne-t-elle?" Things that are commonly accepted as true but have not been fully established, frequently offer the most important fields of research, and the great investigator does not always accept the views of the masses as evidence of truth.

At the funeral of Poincaré the French Minister of Public Instruction remarked that all his work, all his life, was animated by a prepossession, which he expressed in this thought: "The search for truth must be the goal of our activity; it is the only end that would be worthy of it."

An open confession of some of the hidden ignorance of the mathematical scholars has furnished the starting point of many of the most important advances in recent years. In this way Weierstrass started some of the fundamental work relating to continuous functions, and in this way Poincaré clarified a number of questions relating to foundations, especially to the foundation of geometry. The mathematical refinements resulting from such new viewpoints have already taken root in the minds of leaders in other sciences. For instance, Boltzmann said: "The fact that the actual behavior of gases is represented by a curve which can not be differentiated and hence can not be represented graphically leads to great difficulties."[1]

In closing this brief appreciation we may perhaps fittingly quote the words of Sir G. H. Darwin, President of the Fifth International Congress, which met recently at Cambridge, England. At the opening meeting of this congress, held August 22, 1912, Sir Darwin said: "Up to a few weeks ago there was one man who alone of all mathematicians might have occupied the place which I hold, without misgivings as to his fitness. I mean Henri Poincaré."

G. A. Miller

University of Illinois

SCIENTIFIC NOTES AND NEWS

The New York State Education building will be dedicated with elaborate exercises on October 15, 16 and 17. The dedicatory address will be made by Dr. Andrew S. Draper, Bureau of Education, and in the course of the exercises a number of addresses will be made, including one on museums by Dr. Henry Fairfield Osborn, president of the American Museum of Natural History, and one on Educational Extension by Dr. C. R. Van Hise, president of the University of Wisconsin.

Professor Stimpson J. Brown, head of the department of mathematics and mechanics at the Naval Academy at Annapolis, and Professor H. M. Paul, the second ranking officer of the department, have been relieved from duty at the academy and Professor Harry E. Smith has been named as head of the department.

Professor Theodore Fuchs, director of the geological department of the Royal Natural History Museum at Vienna, has celebrated his seventieth birthday.

R. O. E. Davis, Ph.D., lately physicist in the Bureau of Soils, U. S. Department of Agriculture, has been appointed head of the Division of Soils Water Investigation, in the same bureau, to fill the vacancy in that office occasioned by the death of Dr. W J McGee.

Dr. F. D. Heald, professor of botany in the University of Texas, has resigned to become pathologist to the Pennsylvania Chestnut Tree Blight Commission, Philadelphia, Pa.

Dr. S. R. Klein, formerly professor of histology and embryology at the Fordham University School of Medicine, New York, has been placed in charge of the new research laboratories of the Hahnemann Medical College, Chicago.

Mr. Owen M. Jones, who has been carrying on investigations during the last year for the Michigan-Lake Superior Power Co. at Sault Ste. Marie, Michigan, has resigned his position at the Tulane University of Louisiana, where he was in charge of the department of civil engineering, to accept a permanent position with the Power Co.

Professor Hugo de Vries, on his present trip to Alabama to visit the original locality for *Œnothera grandiflora* (see Science for

[1] Klein und Hoefler, "Grenzfragen der Mathematik," 1906, p. 8.

August 30), stopped first for a day at Tuscaloosa, where he was the guest of Dr. Eugene A. Smith, state geologist, one of the pioneer students of the relations between the geology and vegetation in the southeastern states. On the evening of September 21 he was given an informal reception by the faculty of the University of Alabama, in Smith Hall, and described briefly some of his recent observations on mutation in *Œnothera*. While in Alabama he was accompanied by Mr. H. H. Bartlett, of the U. S. Department of Agriculture, who is also a student of *Œnothera* mutants. After visiting Mississippi, Louisiana and Texas, he will go late in October to Florida to study the phytogeography of that unique peninsula under the guidance of Dr. John K. Small, Professor P. H. Rolfs, and perhaps other botanists.

Professor R. B. Dixon, of the department of anthropology, of Harvard University, will spend his sabbatical year in the Orient. During the autumn he will be in western Thibet, but during the winter he expects to pursue his ethnological researches in the Malay states.

Professor A. S. Hitchcock, systematic agrostologist of the United States Department of Agriculture, has gone to the West Indies for the purpose of studying and collecting grasses. He is accompanied by his son, Mr. Albert E. Hitchcock, as assistant. They will go first to Jamaica and later to various points in the Windward Islands, probably visiting last the island of Trinidad.

Dr. A. Hrdlička, of the U. S. National Museum, has returned from an expedition to Liberia and Mongolia.

Professor C. W. Moulton, of Vassar College, has been granted a leave of absence from the college for the year 1912–13. He will pursue special investigations at the University of Berlin.

Leave of absence for the coming year has been granted by Oberlin College to Professor F. E. Leonard, professor of physiology and director of the men's gymnasium. Dr. Leonard will divide his time between work under Professor Kelly at the Johns Hopkins University and study and travel in Europe.

Mr. J. B. Speer, registrar in the University of Montana, has resigned and has gone to Stanford University as private secretary to President Jordan.

Professor E. C. Schmidt, in charge of the department of railway engineering of the University of Illinois, has been commissioned by the Japanese government to design a railway dynamometer car for the imperial government railways. The car will be constructed in this country under the supervision of Professor Schmidt, and is expected to be delivered next spring to the representative of the Japanese government.

Professor G. H. T. Nuttall, of Cambridge University, will give a Harvey Lecture in New York City on October 12 on "The Relapsing Fevers."

"Social Hygiene" was the subject of a recent lecture at the University of California by Dr. Richard C. Cabot, of the Harvard Medical School. He urged the establishment of an efficient national public health department at Washington, physical examination and adequate medical care by school physicians and nurses for every child in the public schools, more attention to industrial hygiene and occupational diseases, and development by which the public hospitals shall more and more care for the general public health.

The Earl Lectures, supported by an endowment of $50,000 given to the Pacific Theological Seminary by Mr. Edwin T. Earl, of Los Angeles, are being given in Berkeley by Dr. Arthur C. McGiffert, professor of church history in Union Theological Seminary, of New York. His subject is "The Rise of Modern Religious Ideas." As a state university, the University of California has no theological department. Several denominations, however, the congregationalists, baptists, christians and unitarians, have established independent theological seminaries in Berkeley which devote their strength and resources wholly to doctrinal and strictly theological training, while their students attend the university for instruction in Greek, Latin, Hebrew, modern languages, history, philosophy, economics, sociological subjects, etc.

Professor G. Frederick Wright, president of the Ohio State Archeological and Historical Society, delivered the main address at the laying of the cornerstone of the museum in Columbus, for the erection of which $100,000 was appropriated by the Ohio legislature. The building, which stands at the entrance of the state university campus, will be two hundred feet long, fifty feet wide and three stories high, and is planned to allow large additions in the future. The chosen purpose of the museum is the housing of the society's unusual collection of relics of the Mound Builders, which is recognized as the finest gathering of such material in existence. Professor Wright has also secured an appropriation of $50,000 from the legislature for the erection in Fremont, Ohio, of a memorial to President Hayes, which will contain the Hayes Library of Americana, which is the famous Clark Library of Cincinnati with the additions made by Mr. Hayes.

A public meeting will be held at the Mansion House, London, on October 23, in support of the memorial to Lord Lister.

Dr. Leonard W. Williams, instructor in comparative anatomy at the Harvard Medical School, was crushed to death by an elevator in one of the school buildings on September 26. Dr. Williams was born at Muskogee, Okla., in 1875, and received his bachelor's degree from Hanover College, his master's degree from Princeton University and his doctor's degree from Brown University, where he was assistant professor of biology; he was the author of important researches on embryology and comparative anatomy.

The deaths are announced of Dr. Stanley Dunkerley, formerly professor of engineering in the University of Manchester and a member of the Royal Institution of Civil Engineers; of Dr. Ernst Becker, emeritus professor of astronomy at Strasburg, and of Dr. Aurel Török, professor of anthropology at Budapesth.

Civil service examinations are announced for two positions in the department of the interior, one for specialist in rural education at an annual salary of $3,000, and one as collector and compiler of statistics at a salary of $2,400.

The Transcontinental Excursion of International Geographers (Professor W. M. Davis, of Harvard University, director), celebrating the sixtieth anniversary of the American Geographical Society, of New York, will be the guests of the University of Virginia on October 12. A symposium will be held at the university in the afternoon on the status of geographical teaching in European universities, in order to show the serious attention that is there given to the fundamental subject of geography as a study of mature grade, presented by expert professors. Addresses will be made by the following speakers: Dr. Joseph Partsch, professor of geography, University of Leipzig, late president of the Geographical Society of Leipzig; Dr. Eugen Oberhummer, professor of geography at the University of Vienna, president of the Geographical Society of Vienna; Lucien Gallois, professor of geography, University of Paris, associate editor of the *Annales de Geographie;* George G. Chisholm, lecturer on geography, University of Edinburgh, secretary to the Royal Scottish Geographical Society; Emile Chaix, professor of geography, University of Geneva and School of Commerce. Addresses by American geographers will be made by Professors W. M. Davis, of Harvard University, A. P. Brigham, of Colgate University, and Mark Jefferson, of the State Normal College, Ypsilanti, Michigan.

The Riberi prize of the University of Turin, amounting to $4,000, will be awarded after the close of the year 1916 for the work which is adjudged to have most advanced the science of medicine.

It is announced that the following sums have been bequeathed by Madame Jonglart for the furtherance of science in France: 50,000 francs to the Collège de France; 95,-

000 francs to the faculty of science of the Sorbonne, of which amount 55,000 francs is to be devoted to the zoological laboratory; 95,000 francs to the museum; 50,000 francs to the faculty of medicine; 70,000 francs to the School of Advanced Studies; 150,000 francs to be divided between the Geographical and Anthropological Societies and the Association for the Advancement of Science, and 139,000 francs to various scientific and charitable institutions.

The Natural History Museum at South Kensington has, as we learn from the London *Times,* received the most valuable gift of the kind which has ever been bestowed upon it. It is the gift of a very extensive collection of exotic and palearctic butterflies and moths which belonged to Mr. H. J. Adams, of Enfield, who died in March last. It is understood that Mr. Adams spent more than £40,000 in acquiring this collection. By his will he had left his collection of butterflies and moths upon trust, with the consent of the residuary legatees, to offer them to the South Kensington Museum for the use of the nation, and his British collection of lepidoptera to the Enfield Entomological Society. The collection of butterflies and moths, which has recently been removed to South Kensington, comprises about 150,000 specimens, contained in 68 cabinets. All the specimens are in excellent condition, and are labelled with the details of the respective localities in which they were obtained. There are at least 200 type specimens of new species described by Mr. Adams.

A press cutting quoted in *Nature* states that Mr. Fisher, prime minister, Australia, referred to the forthcoming visit of the British Association in 1914 in his budget speech on August 1 as follows: "We have been advised that about half as many more members of that association are likely to visit the commonwealth than was anticipated when our invitation was accepted. This will entail an increase in the amount of money which I propose to give towards their expenses; and, speaking for this parliament and country, I say that no greater compliment could be paid to Australia than the fact that our visitors are to be increased in number. It is usual a year or eighteen months before the visit is made to send a representative man of the same class as themselves to get into communication with them. We propose to incur that expenditure pending the expenditure of a larger amount to cover their expenses."

Preventive medicine, hygiene and public health will be the subject of a series of lectures, open to the general public, to be given at 2 o'clock every Friday at the University of California Hospital, the medical department of the university, on Parnassus Avenue, San Francisco. Federal, state and municipal control of disease, vital statistics, pure food, pure milk and pure water, sewage disposal, sanitary engineering, disinfection, social economics and social service in relation to public health will be some of the subjects dealt with.

The council of the Institute of Chemistry, London, are making an endeavor, as we learn from the London *Times,* to raise a fund for new buildings for the institute. Owing to alterations which the London County Council propose to carry out by the widening of Southampton-row, at the rear of the present premises of the institute, 30 Bloomsbury-square—it will not be possible to effect a renewal of the present lease. The council of the institute wish, therefore, to take this opportunity to secure more suitable and permanent headquarters. It is reckoned that with economy adequate provision for the work of the institute can be obtained for about £15,000. The appeal has now been issued nearly three years, and the amount promised to date is about £10,000. As the council will proceed to select a site and prepare plans at the close of this year, they are very desirous of being assured that the full sum of £15,000 will be at their disposal, and it is hoped, therefore, to raise the £5,000 which is still required before the end of October.

The U. S. National Museum of the Smithsonian Institution has recently issued a paper as a contribution to our knowledge of bees and Ichneumon flies, by H. L. Vierick, of the Bureau of Entomology, U. S. Department of Agriculture. In this paper Mr. Vierick describes twenty-one new genera and fifty-seven new species of Ichneumon flies, one new genus of which is named after Dr. Marcus Benjamin, editor of the publications of the U. S. National Museum.

UNIVERSITY AND EDUCATIONAL NEWS

Mr. T. Jefferson Coolidge has given $50,000 for the construction of one of the buildings for the Chemical Laboratory of Harvard University.

It is announced that the Graduate School buildings of Princeton University, now in the course of erection, will in all probability be formally opened in June, 1913, instead of the following September, as originally planned.

The original purpose of American colleges was mainly to train men for the ministry, but at present Harvard gives to this profession barely 2 per cent. of its graduates; Yale now contributes 3 per cent. This and other changes in the professions favored by college graduates are described in a bulletin by Bailey B. Burritt on "Professional Distribution of University and College Graduates," just issued by the United States Bureau of Education. The decline in the numbers going into the ministry has been accompanied by a rise in the professions of teaching, law and business. All three have been more or less consistent gainers at the expense of the ministry. At Harvard the ministry yielded the leadership to law after the revolutionary war, and law remained the dominant profession of Harvard graduates until 1880, when business took the lead. At Yale the ministry competed successfully with law until after the middle of the nineteenth century, when law took the ascendency and kept it until 1895, being then displaced by business. At the University of Pennsylvania one fourth of the graduates used to go into the ministry; now about one fiftieth do so. Oberlin College, founded with strong denominational tendencies, shows the same story of the decline in numbers of men going into the ministry. At the University of Michigan, out of over 15,000 graduates, only 188 have become ministers. Aside from their contributions to the clergy, most of the universities and colleges have had favorite professions. At Columbia, Dartmouth and Michigan, for instance, it is law; at Pennsylvania it is medicine; at Oberlin, Wisconsin, and many others, particularly the co-educational institutions, it is teaching. A final summary of 37 representative colleges shows that teaching is now the dominant profession of college graduates, with 25 per cent.; business takes 20 per cent.; law, which took one third of all the graduates at the beginning of the nineteenth century, now claims but 15 per cent.; medicine takes between 6 and 7 per cent. and seems to be slightly on the decline; engineering is slowly going up, but still takes only 3 or 4 per cent.; while the ministry takes 5 or 6 per cent.

With the appointment of Frank B. Moody, assistant state forester of the Wisconsin forest service, the University of Wisconsin has taken the first steps toward the formation of a course in forestry. Mr. Moody is a graduate of Bates College, Maine, and of the forestry school of the University of Michigan. Mr. Moody's main work will be to organize a school for forest rangers and to give the courses on woodlot management in the university. The forest rangers' course will consist of two sessions of six months each extending over a period of two years. One half of each session will be spent at the university during the fall and winter, the other half in the field during the spring and summer, where instruction will be given by direct practical work on the state forest lands. It is expected the new course will be ready for students by January first, 1913.

Among promotions in the faculty of Oberlin College is that of Dr. George David Hubbard, to be professor of geology on permanent appointment and head of the department. Among the new appointments the most important is that of Dr. Alan W. C. Menzies as permanent head of the department of chemistry, to succeed Professor Frank Fanning Jewett, who retires on the Carnegie Foundation after thirty-two years of service. Dr. Menzies is an alumnus of the University of Edinburgh and has been a graduate student in Leipzig, Aberdeen and in the University of Chicago. Among European appointments Dr. Menzies was assistant professor of chemistry in Heriot-Watt College, Edinburgh, in 1898–1901, and professor of chemistry in St. Mungo College, Glasgow, from 1902 to 1908. He was research fellow in the Davy-Faraday Laboratory, London, in 1901. He is a member of the American Chemical Society, the London Chemical Society and fellow of the Royal Society of Edinburgh. Although retired, Professor Jewett will have a laboratory room in the chemistry building, and plans to give the college service in some much needed work on its mineralogical collections.

Edith M. Twiss, Ph.D. (Chicago), has been appointed head of the department of botany, Washburn College, to succeed Dr. Ira D. Cardiff. James P. Poole, B.G. (University of Maine), has been appointed instructor in the department.

Dr. Harry Beal Torrey, formerly associate professor of zoology in the University of California, has assumed the duties of professor of biology in Reed College, Portland, Oregon.

A. B. McDaniel, of the University of South Dakota, has been appointed assistant professor of civil engineering at the University of Illinois.

DISCUSSION AND CORRESPONDENCE

DRIESCH'S VITALISM AND EXPERIMENTAL INDETERMINISM

In Science of June 16, 1911, I tried to point out the relation of perhaps the most widely known and most influential brand of vitalism—that of Driesch—to experimentation. I set forth that Driesch's vitalism results in "experimental indeterminism," such that "you can not make a statement *which will hold,* that a given arrangement of physical components will act in a certain definite way (even after you have observed how it acts)," because with the same physical configuration different entelechies, or the same entelechy in different manifestations, may be at work, determining diverse results in different cases. Thus I held that it nullifies the fundamental postulate of experimental work, that "when two cases differ in any respect there will always be found a preceding difference to which the present difference is (experimentally) due." I tried to show what a radical difference this would make between biology and other parts of science, in respect to the theory and practise of scientific work, holding it equivalent to an "admission that the principle on which experimental investigation is based breaks down when applied to biology."

In a following number of Science (July 21, 1911) Lovejoy takes sharp issue with my exposition of Driesch's vitalism, saying:

> A closer scrutiny of the doctrine's implications will, I think, disclose in it no such anarchical propensities (p. 78). I think Jennings misconceives Driesch's position in ascribing to him a wholesale "experimental indeterminism" (p. 78).

And after an exposition of Driesch's argument as he conceives it:

> There need in this be nothing arbitrary, nothing to baffle the purposes of the experimenter (p. 78). In all this argument for the non-mechanical nature of organic phenomena there is nothing whatever that necessarily "exempts from experimental determinism . . . that immense field of developmental processes which lies between the egg and the adult," or that necessarily nullifies the experimentalist's postulate that "when two cases differ in any respect there will always be found a preceding difference to which the present difference is (experimentally) due" (p. 80).[1]

And in the classifications of the kinds of vitalism given by Lovejoy in earlier papers (Science, November 26, 1909; and April 21, 1911), he does not so much as mention as one of the possible kinds a vitalism which distinguishes the organic from the inorganic in

[1] What Lovejoy gives here is in reality an exposition of the conclusions which he himself might draw from Driesch's data—assuming these to be the conclusions which Driesch draws.

this profound way. Thus if his point of view is accepted my paper quite lacks a *raison d'être;* I was combating windmills.

In my former paper I made no attempt to show that Driesch's views were of the character that I set forth, because it seemed to me (and still seems to me) that he had stated, in his published works as fully and unequivocally as it is possible in words, that they are of that character; and that, moreover, his whole argument loses its coherence and becomes incomprehensible if they are not.[2] I therefore did not expect any one who had made a careful examination of Driesch's "Science and Philosophy of the Organism" to question this.

Since, however, it has been questioned by one so competent as Lovejoy, with the intimation, as quoted above, that my own scrutiny had not been sufficiently close, it is of interest to learn Driesch's own opinion on this point, when the matter at issue is put explicitly before him. I quote, by permission, from letters received from Dr. Driesch:

You are quite right in saying "the biologist can not from a knowledge of the total physical configuration predict what will happen even after he has observed it." This is indeed a consequence of my vitalism and I am very glad to see that you fully appreciate it.

I reject absolute indeterminism but *accept* experimental indeterminism.

In other words: A complete knowledge of all physico-chemical things and relations (including possible relations) of a given system at the time *t* gives *not* a complete characteristic of that system in the case that it is a living system.

Or: Two systems, absolutely identical in every physico-chemical respect, may behave differently under absolutely identical conditions, in case that the systems are living systems.

For: the specificity of a certain entelechy is among the complete characteristics of a living organism, and about this entelechy knowledge of physico-chemical things and relations teaches *nothing.*

My short formula about the matter in question is: No absolute, but "experimental" indeterminism.

Dr. Driesch's statements of the matter are then fully as strong as my own. If he understands his own philosophy, it therefore appears to me that the further reasoning in my former paper was quite justified, and is entitled to the careful consideration of any others who have leaned toward Driesch's vitalism without realizing that it means experimental indeterminism.

H. S. Jennings

[2] Driesch's argument is one by exclusion, running essentially as follows: Since there are no diversities in the physical conditions that explain satisfactorily the diverse results in certain different cases, and since we must hold to determinism, it follows that there must be something non-physical (*i. e.,* entelechy) to account for the diversities in results. It appears to me that the failure to correctly apprehend Driesch's argument is what causes Lovejoy to intimate frequently that the entelechy concept is superfluous in Driesch's vitalism; merely "dragged into the situation," as he expresses it. Without entelechy a yawning hiatus is left in Driesch's system; it is all that saves him from absolute indeterminism.

ZOOLOGICAL NOMENCLATURE

To the Editor of Science: In Science for August 9, my esteemed friend Dr. Kingsley, makes a plea for various exceptions to the rule of priority in names of animals and to other rules which have been adopted by the Commission on Nomenclature of the International Zoological Congress.

It is no doubt exasperating to many zoologists who have to use only a few systematic names in their work and then at long intervals, to find that in these intervals older names, carelessly or ignorantly neglected in the past, have risen to take their places. It is also exasperating to professional taxonomists and students of geographic and other relations of species, to be told that their efforts to bring past confusion into order shall be set aside whenever these efforts discommode workers in other fields of zoology, who for the most part neither know nor care for the part accurate bookkeeping must play in the study of systematic zoology and botany.

Taxonomy with geographical and geological distribution constitutes a science by itself, with methods of its own wholly separate from those of anatomy, embryology and histology. We have found, by weary experience, that either the use of names must be governed by rule, or else each man may call anything whatever he pleases. The latter has been done too long. We have been for eighty years making progress toward order, and the Zoological Commission has done fairly well in bringing the variant points of view of actual workers in taxonomy into practical harmony. Compromises have been necessary, but we must remember that no compromise not founded in the nature of things will be respected by future workers. The shield of high authority of men like Cuvier has not sufficed to cover his lapses of failure to recognize the work of earlier but less favored authors. Investigators who deal with a few common species may use as vernacular names words like *Amphioxus, Bdellostoma* and the like, not sanctioned by priority, but there is no line which taxonomists can draw which should retain these names invalidated under the law of priority, while retaining order in the other parts of the taxonomic system.

The chief real confusion centers about the need to restrict to a definite type the wide-ranging, ill-defined, incoherent groups of some of the earlier systematists. The genera of Linnæus correspond in general to the families of to-day, while in very many cases, the same species, under other names, appears in two or more different genera.

To limit these genera we have in general two methods. One is to settle the matter on the basis of the words of the original author. If he designates no type, let the first species he names under a genus stand as type. This method has the tremendous advantage of absolute fixity. It would involve a few dozen changes from current nomenclature, but it would stand once for all. Some writers still adhere to it, through thick and thin.

The other method allows the author who deals next with the genus to fix its type. The first one who does so completes the genus and fastens it once for all on some definite species. This method makes necessary much bibliographic research, otherwise unprofitable, and as many writers have no clear conception of generic type, it is often not certain whether such have fixed the type or not.

A third method, that of elimination, by which the type is fixed of a genus for the species which remains after the others have been removed has never been defined and is not practicable. The second method, as a compromise between the first and third, was adopted at the Boston meeting of the Zoological Congress in 1909. If it fails, taxonomists will have no recourse but to fall back into two mutually criticizing camps: those who fix a genus absolutely to the first species named, and those who fix it where they please, according to their treatment of the exigencies of elimination.

The present writer believes that the first species rule would have been best, but as it can not secure a majority vote of taxonomists, he favors the second rule adopted unanimously at Boston. Non-taxonomists have no rights in this matter. We might as well ask them to make their cells visible to the naked eye, laying aside their technique, as for them to ask for the abolition of the technique of taxonomists. To submit to rules of nomenclature "to the plenum of the congress to vote," is to destroy all possibility of taxonomic technique. The botanists have already furnished the awful example. Rules which no investigator can or will follow or which may be set aside in the interest of choice or convenience do not contribute to the fixity of nomenclature.

As to the specific propositions quoted by Dr. Kingsley:

1. To exempt a list of names "in common use before 1900" or "employed in instruction."

It is hard to see by what authority this can be done and the list made permanent. Taking individual cases: *Echidna* is the name of a large and widely distributed genus of eels as well of the Australian spiny monotreme, the eel-name having been in use 140 years. Why should the ichthyologist give it up? As to *Amia,* it is a pity that Linnæus chose that name for the ganoid bowfin when Gronow had used it five years before for a perch-like fish. Personally I preferred to reject all Gronow's non-binomial generic names, leaving *Amia* instead of *Amiatus* for the bowfin, but I follow the decisions of my colleagues. We can not use the same name for two genera. The list of genera, the retention of which is desired as printed in Science, contains 38 names, the changing of most of which has been unpleasant to taxonomists as well as to others. But these 38 we would like to keep are very few among the thousands of generic names which only a recognition of the law of priority and of some law for fixing the type of incongruous genera can hope to regulate.

The second proposed rule is this:

> The transfer of generic or specific names from one genus or species to another shall not be allowed when this will lead to lasting confusion or error.

This reads fairly, but it is not possible to give it definite application. Some names occur so frequently in literature that they may be said to be definitely fixed. Most names the world over have only a tentative status. The fauna of the world is very large, and we are only at the beginning of our knowledge of it. The fauna of western Europe, to which many of the 38 names belong, is only a minute fragment of it. The main source of confusion and error is, however, in leaving a name where it does not belong, after its right place or right usage has been made clear. But if this rule could be lucidly framed so as to permit regularity of application, it has its merits.

The third proposition, the rejection of certain authors on their merits as non-binomial, has its advantages. The non-binomial writings of Brisson and Gronow have been accepted by the commission. A non-binomial condensed reprint of Klein has been rejected. Either view of the case, if generally followed, leads to stability. Before the ruling of the commission Brisson's names were accepted by a majority, those of Gronow, on the same footing, by a minority. The commission has voted to accept both. The matter is likely to come up again at the Monaco meeting.

The fourth proposition, the rejection of non-scientific catalogues, newspapers and the like, might be reasonable if it could be properly defined.

The vital thing is the recognition of law as superior to personal preference or temporary convenience. The "deplorable results" of adherence to the rigid rule of priority are as a drop in the bucket compared to the "deplorable results" that have followed the go-as-you-please acceptance, rejection or change of generic and specific names. And this latter form of "deplorable results" does not trouble the non-systematist who uses scientific names casually as labels for his preparations or who may deal with a small part of a long-known fauna. They vex the systematist who must map out and record some broad part of the vast system of the life of the globe. In his bookkeeping he must follow the same methods throughout regardless of local usage or of personal preferences.

David Starr Jordan

THE PHYSIOLOGICAL SIGNIFICANCE OF THE SEGMENTED STRUCTURE OF STRIATED MUSCLE

To the Editor of Science: In my article, "The Physiological Significance of the Segmented Structure of Striated Muscle," published in your issue of August 23, I make, on page 251, the following criticism of certain current hypotheses of muscular contraction:

> A further disadvantage of the "swelling-hypotheses"—as contrasted with the surface-tension hypothesis—is that they offer no suggestion as to the nature of the connection between the electrical variation accompanying contraction and the contractile process itself.

Some qualification of this statement is now necessary. In Pauli's recent article, "Kolloidchemie der Muskelkontraktion" (Th. Steinkopff, 1912), which has reached me since my article was printed, an attempt is made to refer the negative variation to the formation of acid-protein compounds within the muscle-cell. Such compounds would yield on dissociation mobile anions, *e. g.*, lactate ions, and immobile or colloidal cations. On the assumption of a free permeability of the plasma-membrane to these anions, the formation of such compounds would theoretically give rise to a negative variation. But this conception appears to me insufficient to account for the entire phenomena of action and demarcation currents. In particular, it fails to take into account the relations known to exist between the general permeability of the plasma membrane and the demarcation-current potential. Evidence from many sides shows that this potential varies with the permeability of the plasma membrane to simple crystalloid substances, decreasing as this permeability increases. All cytolytic (*i. e.*, permeability-increasing or membranolytic) substances and processes, so far as known, diminish this potential. Such facts indicate very clearly that semi-permeable membranes form a fundamental if not the chief factor in the production of the demarcation-current potential, and hence also in the production of the action-current which is evidently due to a variation in this potential. Any sufficient reversible increase in permeability would produce under these conditions a negative variation. Obviously, numerical data are required for a decision of those questions. It is not unlikely that several distinct factors are involved in the production of the action-current, and that the observed effect is an additive one. The potential of the action-current is said often to exceed that of the demarcation-current, a fact inexplicable on the simple membrane theory. But if an electrical variation due to a chemical change of the kind imagined by Pauli were superposed on one due to altered membrane-permeability, such an effect might conceivably result.

Ralph S. Lillie
Marine Biological Laboratory,
September 1, 1912

SCIENTIFIC BOOKS

Physik in graphischen Darstellungen. Von Felix Auerbach. Leipzig, B. G. Teubner. 1912. Large 8vo.

In recent years Professor Auerbach has been devoting himself, with success, to encyclopedic treatises on physics. It is not so long since he published his excellent "Kanon der Physik." But the present book is decidedly more novel in design. It will, in particular, be invaluable to teachers. It lends itself at once to the construction of lantern slides for the graphic illustration of involved points in theory. It is furthermore an aid to the setting of graphic problems in all parts of the subject. In a lecture course on light, for instance, almost all the answers to questions can be given by graphs. Such an exercise is easily corrected on the one hand, while on the other it is exceedingly difficult for the student to answer the question by mere copying. It has therefore always seemed to the writer that a similar body of questions, carried throughout the whole of physics, all of them to be answered graphically, would meet many of the difficulties now encountered in case of a lecture course. It is probable that Auerbach's book is a definite contribution in this direction and that a systematic course of questions, to be answered by drawing, may be put together by means of it.

Among the great variety of diagrams and constructions given, all of about the same importance, it will only be possible to refer to a few at random. Thus the curious representation of dimensional formulæ obtained by laying off the powers of *c, g, s,* in terms of length, breadth and thickness, is new to the writer. Graphic classification of different orders of standard magnitude in physics, as, for instance, the prominent distances, times, velocities, densities, etc., occurring in mechanics and the vast number of data in other parts of physics, are bound to be convenient for reference. Constructions relating to equipotential surfaces and lines of force are given in familiar diagrams, but the plates contain suggestive cases of graphic statics, including standard trusses. Similarly the velocity and acceleration hodographs adduced are cleverly chosen. The representation of the cylindroid, however, seems to the writer inadequate.

The subject of elastics both on its experimental and theoretical side lends itself admirably to graphic treatment, and a great variety of constructions is given, including impact, viscosity, hardness, etc. In hydrodynamics the plates abound in practical applications of the subject, in addition to the many exhibits of flow for cases of both rotational and irrotational motion. Waves are particularly well illustrated and the final development of the subject embraces the molecular properties of liquids. The kinematics of harmonic motion is reproduced by an extensive collection of typical cases, after which follows a very full treatment of the graphics of acoustics. The information which is here brought together is extraordinarily rich.

Thermal phenomena are now so extensively known that the graphic method seems almost necessary for their classification. Particularly in the broad subject of solution such a method seems to be the only one adequately available and Auerbach has made full use of it.

The diagrams in electricity are as a rule more familiar, though Auerbach has not failed to introduce much of the recent progress, as in radiology, for instance. Finally, in the section of optics he has had the advantage of long residence in Jena. Throughout the book, in fact, the charts relating to the properties of the Jena glasses are very satisfactory. At the same time the progress there made in optical theory is fully recorded.

The book contains 213 pages and on the average three or four graphs to the page. It concludes with a brief description of the charts together with the necessary bibliographical notes and an index. The charts are throughout up to date, both in their theoretical and experimental references. In looking them over one obtains, perhaps, a more vivid impression of the noble accomplishments of modern physics than can be given by any other method.

Carl Barus

Brown University,
Providence, R. I.

How to Use the Microscope, a Guide for the Novice. By the Rev. Charles A. Hall. 25 text-figures and 20 full-page plates. London, Adam & Charles Black; New York, The Macmillan Company. 75 cents net.

The purpose of this book is well expressed by the author when he says: "It is a guide for the novice, and I have not presumed to offer advice to the expert microscopist." The seven chapters of the book limit themselves to what the novice can really do to start with in microscopic work. Once fairly started, the world is all before him.

In Chapter I. the simple microscope, its advantages and use, are described, and what is said is wholly commendable. In the second chapter there is a discussion of the compound microscope, and the author tells from his own experience how any one can construct a compound microscope. In the third chapter is a general discussion of the use of the compound microscope and the excellent advice given to learn the advantages of low powers. The fourth chapter tells of some important accessories like the substage condenser and the polariscope and the stage micrometer. Coming to the fifth chapter, the real work begins with some common objects for microscopic study. The student is shown where to find them in ponds and ditches, in rock pools of the sea, in the flower pots of the home, in the garden and fields and in the great insect world. He is directed how to prepare and study the things collected, and good books are mentioned which will give fuller information.

In the sixth chapter directions are given for preparing objects and mounting them permanently. This includes mounting objects dry, mounting insects whole in balsam, making sections of plant tissues, staining and mounting them; and finally the making and mounting of rock sections. The seventh and last chapter deals with the method of making photographs of microscopic objects, and the examples of photomicrographs by the author which illustrate his book furnish excellent models.

A critical reading of the book shows that it is unusually free from errors. Its advice is good and one feels sure that it comes from one who has been over the ground many times and has learned the good ways. It seems admirably adapted for the beginner in England. For the beginner in any other country it is not so well adapted, as it tells only of the optical goods, etc., to be had of the London opticians, and the beginner would naturally suppose that he must have the identical things mentioned, at any rate he would know of no others, and the book gives information of no other place for getting them. The American novice, for example, would have no information concerning the excellent optical houses in his own country which supply exactly what is needed; and all worry about the British "methylated spirits" might easily be avoided by explaining that ordinary alcohol or "denatured" alcohol would answer equally well.

It would be so easy to adapt a fundamentally good book of this kind to the country where it is to be introduced that it seems incomprehensible why publishers are not more awake to the advantages of such adaptation.

These suggestions are made in the most friendly spirit, and with the hope that future editions will be made the most useful possible in the new environment; for certainly no one at all familiar with the subject could read these 86 delightful pages, so full of helpful suggestions to the beginner, and so full of enthusiasm for the beautiful world which the microscope reveals, without a feeling of gratitude to the author for making so plain the way into this new realm, for uncovering a road which has no end and which has new beauties for each advancing step.

S. H. G.

The Polynesian Wanderings. Tracks of the Migration Deduced from an Examination of the Proto-Samoan Content of Efate and other Languages of Melanesia. By William Churchill. The Carnegie Institution of Washington. 1911. Pp. 516, 2 maps.

The wanderings of the Polynesians have long been a fascinating crux in ethnology. The peopling of an inconceivably vast area sprinkled with islands appeals to our wonder more than the settling of continents, and from the time of the earliest explorers in the Pacific attempts have been made to hit upon some clew to the dissemination of oceanic peoples. It early appeared that language afforded the best means of tracing these movements and in the gross this index has been used since the time of Hale by students of the Pacific insular races.

Philology has made great strides both materially and scientifically in recent years, however, and Mr. Churchill is foremost among those who have applied the analysis of the content of a language to the solution of the historical problems connected with the migratory movements of peoples, his method in this case being to ascertain the percentage of Proto-Samoan loan words in the Melanesian languages over the area in question and to chart the lines of migrations of the Polynesians along the lines of greatest percentage. The method thus establishes a definite quantitative basis of language research, the results of which are very gratifying.

Mr. Churchill has shown by his percentage measure that the Proto-Samoans emerged from the East Indies, passed out into the Pacific, and with various Melanesian landfalls, reached Samoa, regarded as the primary distributing focus of Polynesians, thence by diverse routes, populating other islands, and in turn streaming from several foci, completing the population of the islands where we now find Polynesians. The earliest movement, according to Mr. Churchill, appears to have taken place about 1,500 years ago.

Among its other valuable qualifications the work is a remarkable analysis of an archaic language which Mr. Churchill hopes will supply the data for the genesis of speech. This, Mr. Churchill modestly puts forward as the feature of his monumental book which will give it a continued and wide influence.

The Carnegie Institution is to be congratulated on the publication.

Two maps accompany the work, the one showing the tracks of Polynesian migration and the other the migration tracks through Melanesia.

There are three appendices, one containing data and notes, two, the southern gateway, and three, a bibliography. An adequate index is supplied. Walter Hough

CHANGES IN THE GERMAN UNIVERSITIES

The former student returning to Germany finds many changes. In the development of the new Germany from the old, much that was familiar has disappeared or has been replaced.

by institutions of a different type. And although the universities have altered less than the nation at large, and the national culture, they too have felt the influence of the years. In particular, the distinction between the city and the country universities has become more marked with the surprising growth of the cities themselves. This holds especially of Berlin. The old university building there remains outwardly the same—one of the few reminders in the present capital of the city we used to know. Only the statues of Helmholtz, of Mommsen, and of Treitschke, by the entrance, suggest that earlier days, and the former giants, have departed. But in other respects there are many changes. The student body has enormously increased, numbering in the last winter semester, if the *Hörer* be included, more than ten thousand souls. And such numbers create new problems of themselves. Class-rooms and laboratories grow crowded: in the summer semester of this year the Philosophical Seminary at Berlin had thirty-five members and sixty-five *Zuhörer*—a *Publicum* almost in itself. And professors are borne down by the burden of their varied engagements, rather than by the pressure of their normal work. But even this army is swallowed up in the metropolis into which Berlin has grown. Did we a generation ago fill so small a place in the life of the city? Perhaps, in the pride of youth, we exaggerated our importance, but it seems hardly possible that we were so little in evidence as the students of to-day. In any case, it is certain that we found conditions then more easily adaptable to the needs of our academic life. The old Berlin student could live reasonably near the university; now, like his professors, he must seek residence remote from the costly center of the town. Not only the price of his lodgings, but his other expenses have increased. About him, also, he finds a more commercial environment, one less in harmony with the spirit of his work. The rush, the roar, the distractions, the temptations of the city force themselves upon his notice in new, it may be unpleasant, ways. In spite of "Amerika Houses" and the several lines of communication between the university and our own institutions, the student far from home encounters problems less familiar, and more grave, than those which his predecessors had to face.

Within the universities, on the other hand, the student of to-day enjoys comforts which our generation lacked. Throughout Germany progress has been made in adapting the conditions of study to the standards of the times. New *Collegien Haüser* have been erected, for example the fine academic center at Jena. Libraries have been built on modern lines, as at Freiburg i. Br. and Berlin. New seminaries, laboratories and clinics have been completed or projected—so just now in Heidelberg one sees the extensive plans for the enlargement of this phase of the university's equipment. And the older quarters have been improved somewhat into modern forms. The change is welcome, even if to our judgment incomplete. For nothing restores one's feeling of acquaintance so quickly as an hour's attendance at a university lecture. In the fine new buildings the rooms seem designed on the familiar lines, the benches and the desks remain, in shape at least, unchanged. As of yore, they cramp the listener's body as much as his mind is expanded by the wisdom which he hears.

The students who throng the precincts of the universities seem familiar, and yet altered. Their comparative youthfulness may be ascribed to a subjective, rather than an objective change. But in certain ways the students of the present generation give real occasion for surprise. They come late to lectures—at least we noticed it in Heidelberg and Berlin—as public sentiment would never have permitted them to do in earlier days. They discriminate in their note-taking, even to the point of shorthand abstracts, whereas it was part of the old dogmatic faith so far as possible to record every word which fell from the lecturer's lips. Strangest of all to the returning veteran is the presence of women. Co-education, at least in the east of the United States, is dying out, we told our German friends. "But why? Our experience is different," came the answer—a reply which corresponded to the evident facts of the case. Not only is the new arrangement established, it appears, as again the Germans themselves witness, to be working with success. Statistics show the attendance, winter semester, 1911–12, of about one woman for every twenty male students in the universities, taking Germany as a whole. Except that, between hours, you see not a few pairs wandering *friedlich mit einander,* the women, further, seem to be accepted on the same footing as the men, and to feel themselves so situated. If some lecturers have enlarged the traditional formula of address into *meine Herren und Damen,* others are more polite and greet the ladies first. The only doubt we heard expressed was whether a woman is fitted by her physique to meet the demands of the highest university education. The majority of the women students, we were told, are planning to become teachers or physicians. Will they be able through the years to support the strain?

One negative experience on a visit to several of the leading universities was unexpected, the failure to meet students of English speech, in particular students from our own country. In Berlin we did meet one or two young Englishmen as they came from lecture; and one American professor was *hospitanting* like ourselves. In Munich we renewed delightful acquaintance with a former pupil working for an advanced degree. Of course, there must have been many others whose paths did not cross our own, and in the summer semester the number of Americans is normally smaller than in winter. But they seem relatively fewer than of old, and the records appear to bear out the observation. For the winter semester, 1911–12, out of 57,398 matriculates in all Germany, 338 is the total number assigned to *Amerika,* under which no doubt our countrymen formed the most considerable part. And if this be compared with the statistics of former years, it will be seen that the number of American students has increased but slowly.[1] The change gives ground at once for satisfaction and regret. That opportunities for advanced training at home have so developed that there is less relative need for foreign travel, is surely ground for satisfaction. If we are really losing, as appears to be the case, the enlargement which a generation or two ago came to many of our most promising younger scholars through their residence abroad, it is a loss which will make itself felt. In spite of the unquestioned value of German scholarship, it was not always that we learned as much as we had expected in the lecture rooms, or in the seminaries themselves. But many of us gained vastly more than we had hoped from our life in a foreign land and acquaintance with continental culture. Especially was this true of the students of the "humanities." The exact sciences derive less from environment and the "intellectual climate." But the historian, the economist, the sociologist, the philosopher, the theologian, even the student of literature, if he be more than a "philologer" of the drier type, is confronted by a dilemma. He remains provincial, or he must live himself into the thought of the world. This he will rarely do with full success unless he shall have shared in foreign culture by personal contact. And the foundations of his sympathy are best laid in his "post-graduate" years.

Of things American, on the contrary, and of American scholarship, much more is heard to-day than formerly. The system of "ex-

[1] Beginning with the winter semester, 1904–05 (when first the statistics were given in the *Deutscher Universitäts-Kalender*) the record is as follows:

Semester	Matriculates	From America
Winter '04–'05	39,719	295
Summer '05	41,533	259
Winter '05–'06	42,051	298
Summer '06	44,964	274
Winter '06–'07	45,136	302
Summer '07	46,655	261
Winter '07–'08	46,471	304
Summer '08	47,799	252
Winter '08–'09	48,717	333
Summer '09	51,500	298
Winter '09–'10	52,407	332
Summer '10	54,393	298
Winter '10–'11	54,823	398
Summer '11	57,200	292
Winter '11–'12	57,398	338

change-professors," "Amerika Houses," and the like is familiar. Even more noteworthy this spring was the attention given to the work of American scholars. At least, this was noticeable in the writer's department of philosophy. At Erlangen, Falckenberg had recently granted a doctorate based on the study of Dewey's pragmatism. In Heidelberg, Troeltsch, beginning his course on the philosophy of religion "for members of all faculties," was discussing pragmatism (as well as the work of the English anthropologists). In Jena, Eucken's "Uebungen" were based on Wobbermin's translation of James's "Varieties of Religious Experience." It would be too much to say that this interest in recent phases of our thinking always indicates agreement. One rather gathers the impression from German scholars that the pragmatic philosophy is not gaining, but losing ground. But it was an agreeable reminder that the scholars and the scholarship of the two nations have come into closer touch. Our indebtedness to the German universities is large. And for some time yet we will continue, if we are wise, to increase our obligations, accepting more than we attempt to give in return. But it was not unwelcome to discover that some beginning of repayment had been made.

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SPECIAL ARTICLES

ANOTHER VIEW OF SEX-LIMITED INHERITANCE

Among results which were obtained by the writer during several years of work in crossing blond ring-doves (*Turtur risorius*) with white ring-doves (*T. alba*), was sex-limited inheritance. When the male bird is white, *i. e.*, recessive, the offspring in F_1 are about equally white or blond like one parent or the other, and the white birds are *all females*. By the reciprocal cross, all of the F_1 offspring are blonds like the male parent.

The blond and the white ring-doves may be distinguished by a group of characters which behave apparently as a unit, so that a simple formula may be used to represent the situation. The white ring-dove differs from the blond bird as follows: (1) melanin pigment is almost entirely absent in the feathers; (2) there is little of this pigment in the skin; and (3) the eyes contain extremely little melanin pigment except in the iris region. In other words, the dominant characters of the blond bird are represented in the white dove in an extremely dilute or very slightly developed form, but they are not entirely absent. Their appearance suggests strongly the idea that development has been arrested.

The late Professor Whitman obtained white females in F_1, when white male ring-doves were crossed with females of the very different species, *Turtur humilis*. This result is mentioned by Bateson.[1] A similar result has been described by Staples-Browne[2] for a cross between a male white ring-dove and females of another very different species, *Turtur turtur*.

A number of other cases as well as these have the common characteristic that recessive F_1 offspring appear when the male parent is recessive, and these individuals are always females. Dominant characters are borne by the F_1 males and sometimes by F_1 females. Thus, two dominant females were obtained by Durham and Marryat[3] with canaries and two by the writer with ring-doves, in crossing recessive males with dominant females.

Cases of sex-limited inheritance which have occurred in animals, and especially with birds, have been interpreted by Spillman,[4] Bateson[5] and others with the following as-

[1] Bateson, "Mendel's Principles of Heredity," University Press, Cambridge, England, 1909, p. 194.

[2] Staples-Browne, "Second Report on the Inheritance of Color in Pigeons, together with an Account of some Experiments on the Crossing of certain Races of Doves, with special reference to Sex-limited Inheritance," *Jr. Genetics*, 1912, Vol. 2, No. 2, pp. 131–162, plates VI.-IX.

[3] Durham and Marryat, "Note on the Inheritance of Sex in Canaries," Report to the Evolution Committee, Roy. Soc., 1909, IV., pp. 57–60.

[4] Spillman, "Spurious Allelomorphism: Results of Recent Investigations," *Am. Nat.*, Vol. 42, 1909, pp. 610–615.

[5] Bateson, "Mendel's Principles of Heredity," University Press, Cambridge, England, 1909, 396 pages.

sumptions: (1) that the male is homozygous for sex and the female heterozygous; and (2) that a "spurious allelomorphism" may exist with the consequence that certain sex and somatic factors may not be present in the same gamete.

These two assumptions are unnecessary if the cytological evidence that male and female determining sperms are produced by the male is regarded. The eggs may then be considered to be all alike. The appearance of recessive females in F_1 may then be explained with the assumption that the female-determining sperms of the recessive male parent may suppress the development of dominant characters in the resulting zygote, or it may be assumed that these sperms lack something which is necessary to the proper development of the dominant characters even when the female parent bears them. Whether this suppressing power or the lack of something necessary for the development of dominant characters is connected with an accessory chromosome or not, is not essential to the assumption.

In the formulæ which follow, the characters of the blond ring-dove are designated by B and those of the white bird by W. Female-determining sperms are distinguished by a subscript $_f$ with an additional $_w$ in the case of those which are produced by the white (recessive) male. It seems more appropriate, and less confusing, also, to call all sperms male and all eggs female, whether two kinds of either exist or not, instead of using the signs of both sexes, as is done commonly, for the gametes of the sex which is considered to be heterozygous. Characters which are recessive to others, in the same individual, are included in parentheses.

1. Blond ring-dove males	×	White ring-dove females.
composition B♂B(♀)		W♀W(♂)
producing gametes { B♂, B_f♂		all W♀
result: Blonds, mostly males B♂(W♀)		Blond females, a few. B♀(W♂)

2. White ring-dove males	×	Blond ring-dove females.
composition W♂W(♀)		B♀B(♂)
producing gametes { W♂, W_{fw}♂		all B♀
result: Blond males B♂(W♀)		White females W_w♀B(♂) becoming W♀W(♂) through presence of condition indicated by subscript $_w$.
		Blond females, occasionally, through absence of $_w$ effect.

As the white F_1 hybrids were all females, it was not possible to breed white hybrids *inter se*. When these white hybrids were crossed back on stock white males, only white offspring were obtained, and they were found to be so-called extracted recessives.

3. Blond F_1 hybrid ring-dove males	×	White ring-dove females.
composition B♂(W♀)		W♀W(♂)
producing gametes { B♂, B_f♂, W♂, W_{fw}♂		all W♀
result: Blond males B♂(W♀)		Blond females B♀(W♂)
White males W♂W(♀)		White females W♀W(♂)

4. Blond F_1 ring-dove hybrid males	×	Blond ring-dove females.
composition B♂(W♀)		B♀B(♂)
producing gametes { B♂, B_f♂, W♂, W_{fw}♂		all B♀
result: Blond males B♂B(♀)		Blond females B♀B(♂)
and also B♂(W♀)		White females B♀W_{fw}(♂) becoming W♀W(♂)
		through presence of condition indicated by subscript $_w$.

Only two successful matings of blond hybrid F_1 ring-doves *inter se* were made, as blond hybrid females were seldom obtained. The expectation for such a cross is given in the following formula. Males and females of both colors were obtained, but their composition was not tested.

5. Blond F_1 hybrid males	×	Blond F_1 hybrid females.
composition B♂ (W♀)		B♀ (W♂)
producing gametes B♂		
B_f♂		B♀
W♂		W♀
W_{fw}♂		
result: Blond males		Blond females
B♂ B(♀)		B♀ B(♂)
and also		and also
B♂ (W♀)		B♀ (W♂)
White males		White females
W♂ W(♀)		W♀ W(♂) and also
		B♀ W_w(♂) or
		W♀ W(♂)

A more detailed description of the results which were obtained by the writer in crossing ring-doves has been prepared for publication, and a preliminary statement[6] has appeared in this journal.

The interesting results, recently described by Cole,[7] are easily explained by this scheme when we recognize that yellow, dun, red, etc., in pigeons are due essentially to less intense melanin pigmentations than that which is represented in black. The dun females in both of Cole's "Cases I. and II.," would then be due to conditions in the female-determining sperms of the recessive male (designated by subscript $_{fw}$ in the formula used in this article). The occurrence of red, yellow and dun in the offspring from the reciprocal cross is not surprising when the uncertain purity of domestic-pigeon stock is considered. Durham and Marryat compared their canaries on the basis of eye-color, as the numerous color variations of the plumage were less satisfactory characters.

R. M. Strong

[6] Science, N. S., Vol. 33, p. 266, 1911.

[7] Science, N. S., Vol. 37, pp. 190–192.

FURTHER NOTE ON THE RESULTS OF OVARIOTOMY ON DUCKS

On July 26 of the present year, one of the ducks (No. 24, now three years old) on which ovariotomy had been performed as recounted in the *Biological Bulletin,* Vol. XX., No. 1, 1910, was killed and dissected. In my original report I stated simply that the bird was castrated, but made no statement concerning the completeness of the ovaries' removal. It is the purpose of this note to supply this lack. But before proceeding to describe the results of the autopsy, certain points should be briefly reviewed.

August 13, 1909, the *left* ovary was removed, no attempt being made to remove the right gonad, which it was assumed had completely degenerated. The duck was then 12 weeks old and already had the secondary sexual characters of the female which are distinct from those of the young male. For nearly a year afterwards this bird passed as an ordinary female. Then it was observed that a part of her feathers were like those of a male. At a moult soon after, she assumed still more of the male's characters, being in the condition shown in Fig. 11 of my earlier report. Subsequently, still more of the male's characters were acquired until her plumage was predominately, yet incompletely, male. For the last 18 months or so the plumage has remained in this intermediate condition, though several moults have occurred in the meantime.

At the autopsy no trace of an ovary on either side could be found. The only duct present was a well-developed but juvenile oviduct on the left side.

The other duck (No. 4), described in the paper referred to above, was examined through an opening in the left side on August 22. The site of the ovary was empty except for a thin strand of connective tissue. As far as could be seen from the left, the right side also was completely empty. This duck, operated on when nearly a year old, had laid several eggs in the period immediately preceding the operation. One was removed from the oviduct at the operation. She has developed only a comparatively few feathers exactly like those of the male in full breeding plumage, the majority resembling, rather, those of the male in summer plumage.

In each of these cases, then, removal of the ovary has been followed by a greater or less assumption of male characters.

Further light on the subject may be expected in due course from the birds on which ovariotomy has been performed this season, several already having feathers like those of a normal male.

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NOTE ON A METHOD OF MIMICKING AMŒBOID MOTION AND PROTOPLASMIC STREAMING IN THE SAME MODEL[1]

The following method of mimicking amœboid motion and protoplasmic streaming has been employed by me for class-demonstrations during the past five years. As it is extremely simple and yields results which are very striking and instructive, it appears advisable to communicate it to a wider public.

It is well known that if particles of camphor be dropped upon the surface of clean water they display energetic movements which are attributed to large and unequally distributed alterations in the superficial tension of the air-water surface at points of contact with the camphor.[2] It occurred to me, therefore, that if camphor could be incorporated into a fluid immiscible with water, drops of the mixture placed upon water might be expected to display surface deformations resembling those occurring in the formation of pseudopodia. This anticipation proved correct.

I prepare a ten-per-cent. solution of camphor-gum in benzol and then, since drops of this water-white liquid are difficult to observe upon the surface of water, I color it deeply by the addition of Sudan III or Scharlach R. If a drop of this mixture be placed upon the surface of water, violent and extremely rapid deformations of surface are observed. Lengthy and irregular "pseudopodia" are rapidly thrown out and withdrawn. The whole drop exhibits a veritable ecstasy of motion which shortly ceases when a fine incrustation of precipitated camphor has spread over the water.

By successive additions of some viscous liquid such as olive oil to the mixture the motions of the drops can be rendered slower and slower and more readily followed in detail by the eye. When at length a mixture is formed of equal volumes of olive oil and the camphor-benzol solution the formation of "pseudopodia" is no longer observed; instead, we observe a prolonged and energetic streaming movement within the drop which mimics in the closest manner imaginable the phenomenon of protoplasmic streaming.

In this way the modifying influence of viscosity upon the reaction of fluid masses to local changes in superficial tension can be shown in any desired gradation; it appears probable that a superficial semi-solid pellicle must restrain the movement of the fluid in much the same way as internal friction. Hence, the phenomena of protoplasmic streaming and amœboid motion are readily traced to the same origin.

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[1] From the Rudolph Spreckels Physiological Laboratory of the University of California.

[2] Van der Mensbrugghe, cited after Rayleigh, *Proc. Roy. Soc. London*, 47, 1890, p. 64.

THE DUNDEE MEETING OF THE BRITISH ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE[1]

The meeting of the British Association at Dundee which has just come to an end will be remembered as one of the pleasantest and most successful in the annals of the association. It was thought to be impossible to surpass the number of members and associates who attended the last Dundee meeting, just 45 years ago; indeed, it was not expected that so high a figure would be reached. But the number this year—2,504—is considerably in excess of the total in 1867, and the support accorded to the association by every one in Dundee, from Lord Provost Urquhart to the humblest citizen, has been most gratifying.

[1] From the London *Times*.

Public and private hospitality have been lavished on the visitors, and nothing that could contribute to their comfort and pleasure has been left undone. The organization has been admirable, and the very heavy work entailed on the honorable local secretaries, Professor D'Arcy Thompson, C.B., Dr. A. H. Millar, and the Town Clerk, Mr. W. H. Blyth Martin, has been carried out without a hitch. The history of these meetings proves that their success depends in a very large measure on the local secretaries, and a generous meed of praise is due to those in Dundee for their untiring efforts on this occasion.

The people of Dundee, moreover, realized the fact, not always present to the minds of the citizens of places visited by the association, that they are most heartily welcome at its meetings, and the way in which they flocked to the reception rooms to take out their tickets rejoiced the hearts of the president and his supporters. If further evidence is needed of the warmth of Dundee's welcome it is to be found in the munificent donation of £10,000 made by Dr. Caird, a distinguished citizen, to the funds of the association. This noble gift, unfettered by conditions, was handed in the form of a check to the president, Professor Schäfer, at the conclusion of his opening address. Of this address, which dealt with the problem of the origin of life, it is unnecessary to speak in detail, since it has been reported fully in *The Times*, and has attracted widespread attention. The origin of life also formed the subject of a discussion between the Zoology and Botany Sections. This was one of the principal features of the meeting, and attracted an audience so large as to necessitate the hiring of a special hall for its accommodation. The social program, arranged and carried out with complete success, comprised a civic reception, a splendid ball, and garden parties, flower shows, and excursions far too numerous for individual mention. The admirable evening discourses by Professor W. H. Bragg, F.R.S., on "Radiations Old and New," and by Professor A. Keith, on "The Antiquity of Man," were attended by crowded audiences; and there were besides three lectures for working men, one by Professor Fowler on the Sun, another by Professor Gonner on Prices and Wages, and the third by Professor B. Moore on Science and National Health, all of which were practical, informing and well attended. A brief summary of the work in the various sections is given below, though it must be understood that it is not possible to cover so wide a field exhaustively.

SECTION A—MATHEMATICAL AND PHYSICAL SCIENCE

Interest in this section centered chiefly in the discussion on wireless telegraphy, when Sections A and G (Engineering) joined forces. From many points of view this discussion was one of the most important features of the Dundee meeting. Contrary to the usual custom, practical achievements were almost disregarded and there was a total absence of those sensational announcements which have tended to become characteristic of public discussions on wireless telegraphy. So far as a section of the public is concerned this may have been unfortunate, but it was welcomed by many of the engineers and physicists present. The points discussed were: the "bending" of the waves to follow the contour of the earth, and the so-called "day-light effect," which makes it possible to transmit signals for a very much greater distance by night than by day, using the same power. Several distinguished physicists and electricians took part in the discussion, among them being Lord Rayleigh, Professor Fleming, Professor S. P. Thompson, Dr. W. H. Eccles and Professor Howe.

Much time was devoted to papers on general physics and mathematics. An interesting discussion took place on the atomic heat of solids, in which Section B also joined. The opening remarks were made by Dr. F. A. Lindemann. On more than one occasion when the section divided into two parts, that part which dealt with general physics fell completely into the hands of the radioactivity enthusiasts, and some excellent papers and discussions resulted. For example, Professor J. C. M'Lennan succeeded in convincing the majority of his audience that the earth's radiation is practically constant and does not suffer any diurnal or other variation. It was interesting to observe also that some attention is being paid to such matters as the velocity and direction of the wind above ground level, and the temperature of the upper atmosphere, for these things must of necessity have considerable bearing on aviation problems.

SECTION B—CHEMISTRY

The proceedings of this section have been spoken of as highly technical in character, but the problems which chemists are now engaged in studying are of a far more fundamental character and far more closely related to the affairs of life than those of most other sections. Theirs is the task of unravelling some of the mysteries on which the president of the association dwelt at length in the opening address, and by some it is held that it will rest with the chemists eventually to say what living matter is and what may have been the origin of life. Two of the sittings were largely devoted to work of this kind. On Friday, when the chemists and botanists combined forces, the papers read mostly had reference to important problems in plant chemistry. On Monday Professor Irvine, of St. Andrews, gave an account of researches on which he has long been engaged, which are throwing much light on the nature of the sugars—a class of substances which play an all-important part in plant life and as animal foods. Again the final sitting was devoted to papers dealing with the mechanism of chemical change, a problem which is fundamental for the understanding of the processes both of organic and of inorganic nature. Other communications dealt with topics of physical interest.

SECTION C—GEOLOGY

The address of the president, Dr. B. W. Peach, was a welcome résumé of the paleontological evidence with regard to the fauna of the Cambrian rocks of the British Isles as compared with that of North America. The interesting problems of the Highlands gave rise to several valuable papers and addresses. Dr. Robert Campbell described the discovery of fossils in the jasper and green schists of the Highland Border near Stonehaven. This is of great interest, as it proves that the beds are not pre-Cambrian, but of Upper Cambrian or Ordovician age. Dr. Jehu supplemented this by an account of fossils recently found in the Boundary Fault series, near Aberfoyle, by which these beds are identified as of Upper Cambrian age.

Dr. Campbell also described an important discovery of the Downtonian (Silurian) Age of certain beds between Craigeven Bay and Stonehaven Harbor, which was formerly classed as Old Red. *Dictyocaris* is abundant, and *Ceratiocaris* is also found. These fossils have never been found elsewhere in rocks younger than the Silurian. Interesting results of the examination of pebbles from the Millstone Grit of Yorkshire were given by Mr. Albert Gilligan, of Leeds University. Large numbers of these pebbles have been collected and sliced, and give evidence of derivation from Scottish or Norwegian sources. Mr. Gilligan has been impressed by the many points of similarity existing between the Millstone Grit and the Torridon Sandstone, and is disposed to think that areas of similar rock types were laid under contribution for each. Dr. J. D. Falconer described the detached hills of South Africa, which possess caps of weathered rock which he attributes to the effect of periods of elevation and erosion following upon periods of decomposition at base-level.

SECTION D—ZOOLOGY

The meeting of this section was undoubtedly one of the most successful ever held. This was due to various contributory causes—to the number and interest of the communications, to the large attendance of British and foreign zoologists present, and in no small degree to the fact that one of the two indefatigable local secretaries is a zoologist of distinction. Two inter-sectional debates were held, one with the Section of Physiology and the other with the botanists. The subject of the former was upon the nutrition of marine organisms. Professor Pütter, of Bonn, was present and opened the discussion with an account of his own work, which he claims furnishes proof of the ability of marine organisms to obtain nourishment from organic solutions present in sea-water. The discussion was animated and well sustained, though it must be admitted Professor Pütter's views found but few adherents. The discussion on the Origin of Life was opened by Professor Minchin. The largeness of the audience was no doubt in great part due to the fact that Professor Schäfer in his opening address had dealt with the same subject. The debate was interesting, and the discussion of such a subject is valuable in the way of "stocktaking," but a final solution is still far remote.

A new departure at this year's meeting was an exhibition of zoological specimens and methods. This was extremely interesting and attracted much attention, especially the demonstration by Professor Leduc of his well-known diffusion figures. It is to be hoped that such an exhibition will become an annual feature and that in future time will be allowed for people to examine it more carefully; an afternoon session should be entirely given up for demonstrations. As a result of the advocacy by the president of the section, Dr. Chalmers Mitchell, of the preservation of wild animals other than those of sporting or economic value, the sectional committee forwarded a resolution to the council of the association drawing attention to the urgency of the matter.

Of the morphological papers perhaps that of Professor Julin on the luminous cells of certain tunicates was the most appreciated. Accounts were given of the work being done at Aberdeen University upon the migration of birds and an inquiry into the food of birds, the latter subject being one of great economic importance. These experiments need to be extended over a period of years before any certain conclusions can be drawn.

SECTION E—GEOGRAPHY

Sir Charles Watson's presidential address dealt with two themes—the history of Sudanese geography since Sir S. Baker was the president of the section at the last meeting in Dundee 45 years ago, and the new international map of the world on the uniform scale of 1/1,000,000. His criticisms on the coloring of the map were supported by the section later when Captain E. O. Henrici, R.E., exhibited the sheets as far as they had been published. It was agreed that an uncolored edition ought to be published as well as the "layer" edition now appearing.

The African branch of the president's address was carried further by the papers of Dr. Felix Oswald (from the Victoria Nyanza to the Kisii highlands), Mr. G. W. Grabham (the country north of Lake Albert), and Mr. P. Amaury Talbot (South Nigeria). A valuable paper was contributed by Mr. E. A. Reeves on recent improvements in surveying instruments, and Sir H. G. Fordham illustrated his paper on the Road Books of the United Kingdom by a varied collection of maps and itineraries. Great interest was taken in the Antarctic discussion initiated by Sir Clements Markham, who sketched the history of Antarctic discovery and the outstanding problems. Other speakers felt that in the praise of Captain Scott something less than justice was done to other explorers, and especially to the expeditions which started from Dundee.

Dr. W. S. Bruce in his paper on the Antarctic continent, after reviewing the earlier discoveries, noted that Amundsen had confirmed Shackleton's discovery of the Antarctic plateau, and traced the Victoria land range to the southeast, as well as finally obliterating the suggestion that the Ross Barrier extends across Antarctica, dividing it into two land masses. The biological evidence confirms the evidence of soundings in favor of a former land connection between Africa and Antarctica. Professor Charles Chilton, of New Zealand, took up the biological point, and showed that the inference extended to South America and Australia. Dr. R. N. Rudmose Brown spoke of the structure of the continent, pointing out that the theory of a great strait completely lacked confirmation. Dr. Marshall described the work of Shackleton's expedition, and Dr. Hodgson, of the *Discovery,* defended the use of dogs against the criticisms of Sir Clements Markham. At the very end of the meeting Sir W. Willcocks gave a trenchant and delightfully entertaining lecture on Canadian agriculture and irrigation.

SECTION F—ECONOMIC SCIENCE AND STATISTICS

This was one of the most popular of the sections. All the papers discussed dealt with practical economic issues of the day, and at each meeting the hall was crowded. Sir Henry Cunynghame, of the Home Office, who presided, said at one of the meetings that he was more interested in the establishing of prosperous and contented communities throughout the land than in the discovery of the remains of creatures which existed millions of years ago, and that saying well expresses the spirit of the section.

In his presidential address Sir Henry Cunynghame also pleaded for a thoughtful and rationalist treatment of economic studies. He did not condemn sympathy, for they were all men and could not but be touched by the sufferings of humanity, but they must be practical in their endeavors to find solutions for social evils. An outstanding paper in the section on the first day of the meeting was that of Mr. Herbert Samuel, M.P., the Postmaster-General, who discussed the tendency to find in a federal system of government the varying and sometimes conflicting interests of the different and widely separated communities of the British Empire. There was also a notable discussion on the results of war by Mr. Norman Angell and Archdeacon Cunningham.

Friday was devoted to a discussion of labor problems. The readers of the four papers treated different aspects of the subject. Professor S. J. Chapman presented the general case for and against arbitration and conciliation in the settlement of labor disputes. Sir Francis Webster gave the manufacturers' point of view, noting the causes affecting prices and wages in the last 40 years. Mr. Ramsay MacDonald, M.P., made a reasonable plea for a minimum wage, varying according to locality and industry, giving labor its due share in the profits, but not unfair to the employers. Mr. C. R. Fay considered the limits within which industrial co-partnership might reasonably claim to be a remedy for industrial strife, and described in detail the schemes in operation at Lever Brothers (limited), Port Sunlight, and those in the English gas companies, where the late Sir George Livesey was the pioneer. A letter relating to conciliation was also read from Sir Charles Macara. Monday's program was more varied. Mr. Allan McNeill discussed the possibility of utilizing national savings for the purchase of agricultural holdings through the machinery of land banks. Miss Annie Ashley instituted a comparison between British and German insurance legislation. Dr. David Heron, in a short address illustrated by lantern slides, gave startling evidence of the failure of inebriates' homes to reform habitual drunkards. Professor Geddes pleaded for the cooperation of the sciences in the town-planning movement and for the preparation of regional and civic surveys for that purpose.

From one point of view the work of the section on its last day was the most interesting of all. The first half of the morning was given to Scottish problems. Mr. James Cunningham, President of the Dundee Chamber of Commerce, gave facts and statistics which are probably not elsewhere procurable, relating to the origin and growth of the jute trade in Dundee and Germany. Mr. Alex. Newlands opened up a fascinating problem—the possibility of developing the water power of the Highlands for industrial purposes. In an impartial paper Mr. J. H. Jones analyzed the effects of dumping on the steel and tin-plate industries, and Mr. A. A. Mitchell closed a most successful meeting with an examination of the question—"Do Trade Unions Raise Wages?"

SECTION G—ENGINEERING

Perhaps the first place among the topics set down for discussion in this section, which was presided over by Mr. Archibald Barr, may be assigned to wireless telegraphy, which has already been referred to under the heading of the section of Mathematics and Physics. A second subject discussed referred to the attempts now being made by workers in different countries to produce a commercial gas turbine. The application of the reciprocating internal combustion engine to the purposes of marine propulsion is regarded as a retrograde step in view of the demonstrated advantages of rotary machinery for such service, and, in spite of the serious difficulties which have to be overcome, it is felt that the efforts being made to construct a commercial gas turbine is a movement along the right lines. A certain measure of success has, indeed, already been achieved, and with so many minds attacking the subject in different ways it is probable that success will be attained at no very distant date. The discussion which was opened by Mr. Dugald Clerk showed what has been done and what has still to be accomplished.

The research on the gas engine itself which is being carried out by the Gaseous Explosions Committee of the British Association is to be continued. The report presented to the present meeting made it clear that useful work is being done by this committee in the settlement of disputed points and in throwing light upon certain questions which have hitherto baffled designers of gas engines. A set of interesting papers on marine problems and developments in marine propulsion opened up a discussion on several matters of current interest. Questions relating to the provision of lifeboats on liners and the special means whereby quick launching may be ensured were the subjects of a paper by Mr. Axel Welin. Another paper showed the real dangers in navigation arising from the suction effect between passing vessels, concerning which there has been a serious conflict of opinion. The case for electrical methods of ship propulsion, which is being closely watched by the British Admiralty, was discussed from the expert standpoint for the benefit of the lay mind.

SECTION H—ANTHROPOLOGY

In the proceedings of Section H (Anthropology) much interest attached to Professor Anthony's exhibit of the cast of the La Quina brain—one of the first examples of a brain of paleolithic man of Neanderthal type to be described and one of the finest yet discovered—as well as to Professor Keith's communication on the Gibraltar brain, which afforded strong corroborative evidence in support of the theories of the evolution of mammalian and especially the human brain elaborated in the president's address. Dr. Duckworth's description of the jaw of paleolithic antiquity found in Kent's Cavern, Torquay, in 1867, but not previously described, which was presented to the section by Professor Boyd Dawkins, was another interesting and important contribution to the study of the antiquity of man—a subject much in evidence at this meeting. Professor Elliot Smith's views on the origin of megalithic monuments, which he associates closely with the beginnings of the use of copper in Egypt, whence he holds the adoption of this form of burial monument spread over the remainder of the world, gave rise to a discussion in which these views were strongly criticized and a number of profoundly interesting questions were raised. The discussion on the ethnological aspects of Scottish folklore, if it did not succeed in elucidating any particular problems of Scottish ethnology, at any rate brought out the fact that many primitive customs still survive in different parts of the country and will undoubtedly serve to stimulate interest in a subject in which the serious workers are regrettably few. Papers dealing with Egyptian archeology and the ethnology of the Sudan were unusually numerous.

Professor Elliot Smith in his two papers, one dealing with the earliest attempts at mummification in Egypt, and a second dealing with the physical character of the Egyptians of the second and third dynasties, has traced to a higher antiquity than had previously been done the use of this method for preserving the body of the dead, and in the second case has demonstrated the existence of an alien population in Egypt at an earlier date than his previous researches had revealed. Dr. Wood-Jones's paper on the Ancient and Modern Nubas showed that there is evidence of this same process of infiltration of an alien element in Nubia in early Christian times. Mr. Robert Mond's colored illustrations of the Theban tombs excavated by Mr. Gardner were greatly appreciated, both on the ground of their beauty and of their scientific value as accurate records. The papers of Professor Petrie on early dynastic discoveries, and by Mr. Quibell on tombs of the second and third dynasties, both contained important contributions to the study of Egyptian antiquities. To archeologists a melancholy interest attached to Mr. Ogilvie's paper on the Temple of Philæ. The colored slides shown to illustrate the paper were reproductions of recent sketches, and probably will be the last records to be made of the temple, which will be finally submerged in November.

SECTION I—PHYSIOLOGY

Mr. Leonard Hill presided over this section and devoted his address to the important question of ventilation in its relation to health. Some interesting information was given by Professor J. S. Macdonald, who, as a result of calorimetric observations on man, concluded that 25 per cent. of the energy transformed during work is converted into mechanical movement. His experiments were conducted in the large calorimeter at Sheffield University. Dr. A. D. Waller gave an account of the original physiological work done by Patrick Blair about 200 years ago in correctly describing the nerves of the trunk of an elephant which died near Dundee. He dissected the carcass of the animal until, owing to its decomposition, he was compelled to desist. Its bones were subsequently ground to powder and used to fertilize the fields. This section devoted a morning to a discussion on the relation between mind and body—a subject which proved extremely attractive. Another discussion was held in conjunction with the Zoology Section. This had relation to the physiology of marine organisms. Dr. Edridge Green criticized the report of the departmental committee on sight tests. He condemned the wool test as not being efficient in detecting color blindness; and also criticized the form of lantern recommended by the committee, and the method of flicker photometry. Professor Gotch and Professor Sherrington agreed that the wool test was quite inefficient and should not be retained; but they defended the lantern and the form of photometer recommended by the committee.

SECTION K—BOTANY

Two of the most interesting papers in the Botanical Section were read by Dr. C. H. Ostenfeld, of Copenhagen, and by Professor F. E. Weiss, of Manchester. These dealt with the question of hybridism in plants. Dr. Ostenfeld confined his remarks to the genus of hawkweeds (*Hieracium*), one of the most difficult genera with which systematic botanists have to deal, on account of its remarkable polymorphy. As Dr. Ostenfeld showed, some species of *Hieracium* reproduce themselves without fertilization, whilst other species require this; and in a third set of species both modes of reproduction obtain. Crossing species of one of these sets with another, hybrids were obtained; and these first crosses differed remarkably among themselves, thus differing from the first crosses of other genera, which are remarkably uniform. The offspring of the first crosses, however, were quite uniform, thus differing from later crosses of other genera, which are remarkably polymorphous. Dr. Ostenfeld concluded that in this genus of plants new forms have arisen and are arising at the present time (1) by hereditary variation of already existing species, (2) by hybridization and (3) by a combination of these methods. From those forms which reproduce themselves without fertilization very few new forms arise at all; but there are indications even here that new forms arise occasionally by mutation. Dr. Ostenfeld's paper may be regarded as the first step towards a real synthesis of the extremely numerous "species" of the genus *Hieracium*.

Professor Weiss's paper dealt with artificially produced hybrids of two common British species of avens, *Geum rivale* and *G. urbanum*. The first cross agrees with plants named *Geum intermedium*.

Some of the later crosses agree with other hybrid forms described by systematic botanists. It is remarkable that two such well-marked species as the water avens (*G. rivale*) and the wood avens (*G. urbanum*) should produce so many fertile hybrid forms that a very complete series of forms can be obtained connecting the one species with the other. In the discussion which followed it was suggested that the same phenomenon which is happening in *Geum* is happening in the allied blackberries (*Rubus*), a genus as polymorphic as *Hieracium*, except that in *Rubus* there are several (perhaps six or sixty) true species, most of which are hybridizing with one another, and that many of the so-called "species" of *Rubus* are merely hybrid forms corresponding to those artificially produced hybrid forms of *Geum* made by Professor Weiss.

Several papers on ecological botany were read, of which one of the most important was that by Miss Rayner on the Ecology of the Common Heather (*Calluna vulgaris*). The semi-popular address, which was well attended, was delivered by Mr. I. H. Burkill (the newly appointed director of the Botanical Gardens of Singapore) on "The Botanical Results of the Abor Expedition."

The section was well attended, especially by the younger members, and several interesting excursions were made. The visit to Dundee will long be remembered by the members of the section as among the most generally useful and interesting of any meetings of recent years.

SECTION L—EDUCATION

The Education Section marked in various ways an advance upon the time when it was a mere battleground for those who favored this or that method of teaching particular subjects of the school curriculum. The origin of the section was due, in fact, to men who were in the main concerned with the teaching of science. They were not interested in the deeper problems of education; probably, in fact, they would deny that it had any problems other than those which were concerned with how much of the science master the schools ought to tolerate. Obviously, however, if the section was to justify its independent existence, it must take its own line and call to its councils those who make education in the scientific sense of the term their chief concern.

The appointment of Professor Adams as president was in fact a recognition on the part of the council of this claim to independence, and Professor Adams's address on the possibility of an objective standard in education will take rank as a very sane and moderate statement of the present position of the subject as a science. Less directly addressed to the popular mind than is usual, it will be read with marked attention and pleasure by the new school of educational research which is slowly making its way, stimulated perhaps by the influence of the new school of psychology. If it contained no new or startling discovery, the presidential address pegged out the claims, so to speak, upon which education may hope ultimately to take full rank among the sciences.

Closely allied to the presidential pronouncement was the discussion on the psychological processes involved in reading and writing. A report from a research committee presented the latest statement of the results of psychological inquiry, and some admirable papers were read, leading to the general view that much ingenuity is at present misspent in setting up positive hindrances to the rapid acquisition of the art of getting at the meaning of the printed page.

Less technical in its appeal was the discussion on vocational training. Miss Faithfull's was in effect the only dissentient voice in the general call for a curriculum more closely directed to the actual situation of school pupils. There was some little uncertainty about the meaning of the word vocational. Obviously, if a lad is to spend his life in one of the 95 independent operations which enter into the making of a pair of boots, school time would be wasted if its activities were thus confined. The problem of how to give point and meaning to school "lessons" has yet to be solved. It is at least a step forward when the desired end is clearly laid down.

There were interesting discussions on school leaving certificates and the present position of mathematical teaching. Two distinguished physicists, Professor Sylvanus Thompson and Principal E. H. Griffiths, lamented the loss of Euclidean geometry, though there was a general agreement about the value of the work which men like Dr. T. P. Nunn are doing for the humanizing of mathematical studies.

Not the least important of the actual accomplishments of the section was the report on school-books and eyesight. The committee has laid down standards of type, etc., which must profoundly affect the production of school-books and the hygiene of school life. It is much to be hoped that the council of the association will give wide publicity to that report.

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ANTON DOHRN[1]

To speak of Anton Dohrn before zoologists is both easy and difficult. Many, perhaps the greater number, of you have known him personally, some longer and better than I; and all know his work. Of his aims and their attainment he has left us his own graphic recital full of personal charm; and others have paid tribute to his achievements in a manner so incomparable that I can not hope to bring to you anything new. But I have been encouraged in this undertaking by the thought that I do not first need to arouse in you sympathy for his personality. What I have to say will awaken in most of you an answering chord, recalling so many varied reminiscences that my aim will be accomplished, even though my words fail in their expression. So bring back to your mind the image of the beautiful white building with its red loggias, against the dark background of green ilex; picture this building as it stands on the shore of the Bay of Naples. Upon the facade zoologists read with pride the words "Stazione Zoologica," telling each one that here stands a temple of science symbolizing their aims and ambitions. More than two thousand square meters are covered by this building containing more than 150 rooms, in which fifty persons, officials, technicians, artists, fishermen and laboratory servants are continuously engaged in work. At Easter time the visitor to the station will find there as many

[1] Memorial address delivered at the International Zoological Congress, Graz, August 18, 1910, by Dr. Theodor Boveri, professor of zoology and comparative anatomy, Wurzburg. (Translated for Science.)

as eighty investigators busily occupied, and a tour of inspection from room to room in reality carries him through the whole range of biology. In the course of thirty-six years many embryonic biologists have been attracted here to study for the first time the wonders of marine life. Here investigators have come from every civilized land, because the scientific problems they had in mind could nowhere else be studied to such advantage. How many hours of happy work, how much of the joy attending discovery, has this building seen! The tables of the station have been occupied more than 2,000 times, while the number of scientific experiments either originating or deriving their inspiration here can not be estimated. Add to this total all that the station itself has contributed to scientific work; the help given to zoological investigators by the *Jahresbericht;* the material supplied for museums throughout the world, as well as for teaching purposes, and last but not least recall the fact that this institution since its foundation has served as model and inspiration for the establishment of zoological stations in many different countries. Remembering all this, we can but echo the words of the address delivered at the station's International Jubilee Celebration in 1897:

> We can not imagine what the position of the biological sciences would be at this time had the far-reaching influence of the station been eliminated.

Should we wish to express as briefly as possible what this influence has been we would say that Dohrn's Station first made the study of marine life practical. For a long time occasional soundings had been made by a few persons, and they had revealed the hidden treasure. Similar institutions were established about the same time as Dohrn's by contemporary leaders in the field of zoology, Henri de Lacaze-Duthiers and, in America, Louis Agassiz, not to mention other smaller undertakings. But in making the great treasure available Dohrn was the first, and this marks the importance of his work in comparison with all others. In this we have an objective measure of his work. Each one of us, profiting by the studies made at the Naples Station and conscious of having added another stone to the growing structure of our knowledge, must imagine his own part increased a thousandfold, if he is to measure the entire scientific contribution made possible by Dohrn's creative genius. With this in mind we must realize how immeasurable was the influence he exerted on biology. Not only does time fail me, but I am not in the possession of the facts necessary to follow in detail the course of the newer streams of knowledge arising in the zoological station, and spreading out over the most widely separated fields of biology. I shall direct your attention to only one branch in the wide field of enquiry carried on in the station, namely, that which may be described under the head of causal morphology. Judged by what has been gained in the study of marine organisms and realizing that without the opportunities offered by these stations the results would have been unattainable, the part taken by the oldest and largest of these institutions at one of the most critical moments in the history of our science entitles it to the highest reward.

Anton Dohrn, the man to whom we owe all this, was born December 29, 1840, in Stettin, now almost seventy years ago. When one hears his father's personality described there is no doubt that the son resembled him in outward appearance and inherited from him what was best in his parent's character. The possession of ample means permitted the elder Dohrn to order his life according to his inclinations.

To live life to the full, as Goethe expressed it; to develop all his inherent powers; to take as comprehensive a view as possible of all fields of learning, these were his guiding principles. In the house of this unusually talented musician were heard artistic renderings of the chamber-music of Beethoven and Schubert, while as an accomplished linguist he made finished translations of Spanish dramas. Far and wide he was known as an entomologist, as well as the founder and director of an influential entomological journal published in Stettin. These and other undertakings enlivened an immense correspondence which he carried on with a circle of prominent men, and such relationships were further developed by frequent journeys to Italy, which country of all others gave the greatest pleasure to this man, fascinated by the beauties of nature, antiquities and the charm of Italian life.

In such surroundings, with three equally gifted brothers and a sister, Anton Dohrn grew to manhood, and those who knew him well recognized in him many of the qualities possessed by the father. At seventeen years of age, this precocious youth (who had already passed without difficulty through the gymnasium) published articles in entomological periodicals. We can imagine him on the threshold of the university, full of strength and love of life, abounding in enthusiasm for a multiplicity of interests, developed under the father's influence, and by unusual teachers. The world as Goethe saw it was his confession of faith. Dohrn himself regarded it as an accident that with his traits he should in those times have become a zoologist. The entomological leanings of the father, who had interested his three sons while yet boys in the art of collecting insects, gave the first impulse in this direction, but his real interest was not yet aroused. What could zoology as it was taught in his student years, in the early sixties in Königsberg, Bonn and Berlin, offer to his hungry mind? Disappointed at the time already lost, he had the notion of giving up his studies and becoming a publisher, when the appearance of Darwin's work brought an illuminating ray suddenly into his life. When we consider how many of us have been drawn into biology, from widely separated fields of interest, by the doctrine of descent looming up before our minds, we can easily imagine what an anchor of safety was offered by this vision to a young zoologist of Dohrn's temperament and education, already despairing of his ground. Here was the turning point in the life of one who scientifically was in despair. At one bound zoology took for him its place as the central point of all knowledge. What had appeared to his mind as without continuity, suddenly became most perfectly connected. Like many others of his time and later, he had the feeling that here if anywhere the riddle of our being must find a solution. Without doubt the manner in which the new teachings were presented by Haeckel and Gegenbauer must have had great influence on this revolution of his thought processes. Following the advice of these two men, he matriculated in 1868 at Jena, and it appeared at first as if his life too would find its aim and end in the chair of a professor of zoology, but Dohrn's personality forced itself out from this career and created a new sphere of existence. Later he gave two reasons for breaking away from the academic career. Often when working by the sea he had felt the great need of laboratory facilities. A profitable field of activity in Jena hardly seemed longer possible, as a result of an increasing divergence of his scientific views from those of Gegenbauer and Haeckel. Little as we can doubt the strong influence of these motives, it seems to me that they were only the expression of an impulse, unconscious perhaps to Dohrn, to bring those powers into play, which as privatdozent, he would be forced to suppress. He longed to create something great all his own, to wander on new and untrodden paths. This desire showed itself in his earlier project to become a publisher, as it was his wish to choose a field of practical activity affording full play for his intellectual talents. When the earlier indifference towards the adopted science had been changed into enthusiasm, this impulse, as a matter of course, chose for its objective, zoology. Beginning with taxonomy, imbued with Darwinian theories and accepting transmutation as a physiological problem, he had already gained a comprehensive view of the needs of his science. He had ever before his eyes the lesson the sea had taught some of his fortunate predecessors, especially as recorded in the brilliant results of Johannes Müller's work. His own experience had often shown him how much more advantageously these marine organisms could be utilized if the experimenter, hurrying from inland to the coast for a short season, found there even a primitive laboratory. The founding of a marine zoological station offered the needed medium for the expression of this strongly felt impulse to develop his great personal powers.

In the winter of 1870, Dohrn went to Naples, hoping to realize his plan, but the negotiations entered into were soon interrupted by war which recalled the young officer to Cassell (on account of an earlier illness he had been transferred to the reserves). In the fall of 1871 Dohrn removed permanently to Naples, and forthwith began the great constructive period of his life. To-day the biologist comes to Naples and sees the Zoological Station standing in the public gardens, of which it is almost an integral part. On going to work he finds not only the material for his experiments, but apparently everything needful for their elaboration, even complicated and specialized equipment being brought to him with business-like promptness. In addition he has easy access to a library of such completeness as nowhere else could be at his disposal—in brief, when the occupany of a Naples table, a veritable "Tischlein deckt dich" allows him to concentrate his thought entirely on his work, he accepts all in its completeness without realizing the indescribable toil and self-sacrifice with which this now perfect institution has been brought into existence. And I too must confess that even though I had known the station in its beginnings and had read and heard much as to its origin, it was first through the manuscripts left by Dohrn in which he speaks of the formative years that it became clear to me what courage, what self-denial, what inexhaustible patience, what an intimate acquaintance with the most varied realms of knowledge, what an art for grasping situations and handling men, had been brought into play in this creation. Dohrn himself, speaking twenty years later of this time, said:

> It now often seems to me as though like a sleepwalker I had safely passed all the pitfalls that lay on either side of my way. Without a model as precedent, with entirely insufficient pecuniary resources, absolutely without business knowledge, in a foreign land, of whose language I knew little or nothing, I signed an agreement with the authorities of the city which of all others in Italy is the most difficult to administer. From the time of the first negotiations in the city hall in Naples, in November, 1870, to the opening of the station in February, 1874, I passed through an Odyssey of wanderings.

Do we hear in these words the approach of that period in life when in retrospection one doubts the power of youth (even one's own) to have accomplished what has been done and which perhaps one is no longer capable of doing? His own words make us realize the size of the undertaking to which Dohrn had committed himself. No man of experience, upon hearing of the plans, believed them to be practical, and the more intimate the knowledge of the critics, the more were they convinced that this fantastic undertaking would meet with nothing less than failure. But these prophecies left out of the reckoning one thing, which alone action could bring to life, namely, Dohrn's iron will and his unusual abilities.

Within the limits I must set myself in this address, it is impossible to give a picture of the difficulties with which Dohrn had to contend during these years. When, as we dare hope, that which he has written of the drama of these early years at last reaches print, no zoologist will fail to read it. As one example only, we will cite an episode out of many similar ones which might be chosen. In the autumn of 1872, when the building was almost ready for the roof and Dohrn at the time was lingering in Berlin, in order to seek support for his undertaking in the Academy of Science, from the Prussian authorities and from the crown, he suddenly received from Naples a telegram to the effect that the municipal authorities had stopped the building because the height agreed to by contract had been exceeded. This was in truth the case. In consequence of an incorrect level, it became necessary to exceed the prescribed height by a couple of meters, unless the whole structure were to be reduced in size. This infraction of the agreement aroused anew the smouldering fires of suspicion. All the enemies and envious critics, all those whose profits had been interfered with, again rose, and soon the rumor was rife that the building must be razed to the ground. Dohrn hastened immediately to Naples. It was autumn and the season of the heaviest rainfall was imminent. Unless great damage were to be done, the house must at once be put under cover. But notwithstanding every effort, he was unable to obtain more from the municipal authorities than the permission to carry on the work at his own risk. A settlement of the question as to the height could not be reached. Not an instant did Dohrn pause to consider; the precious time must be used to advantage, and the work of building continued. He was also confronted with the problem how to procure funds to pay the indemnity occasioned by the slight excess of height. The straining of every nerve had to be begun again in order that those upon whose favor the success of his enterprise rested might be reconvinced and rewon. This work he had believed to be behind him. But all ears appeared closed. Week after week passed and nothing was attained. Still undisturbed and unaffected by the damage that a deluge of unusual and unprecedented severity had occasioned, he pushed his building operations towards completion. Suddenly a command came from the city authorities that the work must be definitely discontinued and, as if this were not enough, at the same time bad news arrived from Berlin. Du-Bois Raymond, in whom Dohrn had found a friend and sympathizer, wrote him that the circle of intellectuals in Berlin with whom rested the final decisions, were so unfavorably disposed that no aid from the academy and thus no subsidy from the German government could be counted upon. Du-Bois Raymond deeply regretted being obliged to communicate to him anything so adverse to his interests, and hoped that Dohrn would not allow himself to be cast down, but would make every effort to get the necessary help elsewhere. The evening of that same day Dohrn was on his way back to Berlin, and before Du-Bois Raymond could expect even an answer to his letter Dohrn was before him in person. He begged his well-wisher to tell him what were the dangerous weapons which according to the letter would be directed against him. As Dohrn had suspected, it was, on the one hand, doubt as to his scientific abilities, by which means Professor Peters had prejudiced his Berlin colleagues against the undertaking, and, on the other hand, it was rumored that the Zoological Station was a commercial venture, and as such should not be subsidized by the government. As soon as Dohrn received this information he replied that he had determined nevertheless to get the money he needed in Berlin; and so, as in Naples, a similar personal campaign was carried on, but with better success. From one opposing academician he went to another and soon succeeded in disarming the most hostilely disposed; the others he convinced of the importance of the beginnings he had made, and of the correctness of the chosen ways and means. One of the amusing pronouncements let fall at this time by the veteran Ehrenberg may be cited here. Ehrenberg affirmed that if Dohrn attacked the fauna of Naples with such an armory of equipment and helpers, in five or ten years there would be nothing left there to investigate. This Berlin campaign lasted fourteen days, in which time he was also able to win to the cause a few more valuable patrons to aid in the further development of the station, and through them was enabled to reach the ear of the crown prince.

He next returned rapidly to Naples, where the opposition to his undertaking had reached the highest point. The German consul general received him with the information that he believed the day to be lost. Public opinion demanded the tearing down of the building. This rumor was verified at the office of the municipality. Every means to turn the tide seemed to have been exhausted. Dohrn's article entitled "The Present Position of Zoology and the Establishment of Zoological Stations" had just appeared (translated into Italian) in an important monthly, and this saved the day. This publication Dohrn sent to the most influential of the city authorities without indeed hoping much from it; but in one case at least the seed fell on good ground, namely, with Baron Savarese, at that time the powerful leader of the selectmen. He expressed a wish to make Dohrn's acquaintance and in a conversation that lasted for three hours Dohrn succeeded in winning over for his project this man who was as intelligent as capable, so that Savarese promised to carry the cause to victory in the municipal council despite its enemies. Ten days later he had made his promise good. Almost at the same time the news came from Berlin that the governmental subsidy for the next year was assured. And thus was taken the first step so immensely important for the continued success of the station, in its assurance of the repetition of the grants from the German and Italian governments. In this way were these two, perhaps the greatest crises in the history of the station, safely passed. Trying as were such times, they show us Dohrn in his element. He appeared as a general on the field of battle. Nothing discouraged, intimidated or turned him aside. In every situation he appeared the same; what others believed to be impossible his penetrating insight resolved into a number of difficulties, but all possible to overcome. No trouble was too great for him to take, no step too hard, no smallest possible opportunity was too insignificant for the forwarding of his plans. His letters went in all directions. He quailed before no journey, no matter how difficult. He attended congresses in order to inform his professional associates of his hopes, and by means of fascinatingly written articles he instructed and interested the educated classes. He visited numberless people and imbued them with the same inspiration by means of his selfless enthusiasm, through his knowledge of the world, his eloquence of speech and power of repartee. Each new patron gained served as the point of approach to other connections, until he at last reached the place where decisive steps must be taken. With astonishing rapidity he familiarized himself with conditions previously foreign to his life. He was inexhaustible in thinking out new methods, but restless as was the working of his imagination and impulsive as was his character from childhood, he soon learned that unremitting self-control which permitted of no undue haste. He knew that situations change, he knew the mutability of public opinion, what human decisions mean, and that they none of them are unchangeable. Patiently he was able to wait, but like the eagle in the air, his eye was upon the object of his desire, and he swooped upon it as soon as it was attainable. And all these traits were held together and crowned by an unusual strength of mind, which, to quote Jacob Burchhart, "alone is able and therefore loves alone to sail through storm."

As you all know, the origin of the Zoological Station rests on two entirely original ideas of Dohrn's; one of which was to connect with the laboratories a public aquarium such as already existed in London, Hamburg and Berlin. His idea was that the income that these other aquaria were paying to the stockholders in this institution should be used for the benefit of science. Dohrn has said, and it has often been repeated, that this idea came to him on the fourth of January, 1870, as he rode in the mail coach from Apolda to Jena. "It came to me," so he writes, "like a revelation, and a limitless horizon of attainable results appeared to my feverishly working fancy." This fundamental idea demanded for its field of operation a large, much-visited city on a seacoast rich in fauna, and this determined the choice of Naples. As it was later shown that the admission to the aquarium would not suffice for the cost of current expenses, Dohrn fixed upon his second chief idea—to secure for the station an enlarged and stable income by renting out to governments and corporations tables for work. And it was chiefly this so-called "table" system which gave an international character to the station. The station is self-supporting, and both ideas have proved to be successful. The subsidies of the German and Italian governments pay for "tables." Dohrn realized, however, that in the beginning this would not be practicable. First of all a large capital had to be secured for the furnishing of the building; and this sum came mainly from Dohrn's father. In the address made by Dohrn in the spring of 1897, as the station was celebrating the twenty-fifth anniversary of the laying of the cornerstone, Dohrn spoke with loving expression of filial reverence, of all that he mentally and materially owed to his father; but one must not think that his father's help came to him without trouble or battling. No one was more firmly convinced than this very father that his son was following a Utopian scheme, was chasing a will-o'-the-wisp, sure to result in a pitiful fiasco. He not only firmly refused every appeal for aid, but a complete break which lasted a long time between these equally hard heads was the consequence. The quiet soothing influence of Dohrn's mother aided much in the solution of these differences of opinion. When the son had succeeded without his father's help, and the latter, against his will, was forced to acknowledge that he had thoroughly misjudged the character and capabilities of his son; and when letters from Darwin, K. E. von Baer and other notices of the importance of the newly founded Zoological Station left no further room for doubt, only then did he grant the sum which Dohrn would later have inherited. Fortunately, for many years he was able to enjoy the ever-increasing success of this son.

In the year 1873, as the station was nearing completion, a picture was placed beside the other frescoes which adorned the walls in the hall later to become the library, but then planned as part of Dohrn's residence —a picture which as a document of the time will become more and more valuable as the years go on. The painting shows us five young men who had gathered together about Dohrn in Naples. The highly gifted and unusual Nikolas Kleinberg, chosen by his friend as director of the laboratory; next him the English poet and writer, Charles Grant, who, enthusiastically emersing himself in Neapolitan life, became the beloved interpreter for his friends of their new environment; Adolf Hildebrand, the sculptor, to whom the exterior elevation of the building suggested by Dohrn owes its artistic harmony, and in the background of the picture is Hans von Marees, the painter himself. To-day these frescoes attract to the Zoological Station the art connoisseur, almost as much as the biologist. Here we see these friends, joined a little later by the gifted Francis Balfour as in the ruins of Posilippo they sit together over a glass of wine at the end of a full day's work. On one such evening the exuberance of their joy in living found expression by their decision to swim to the Castell Dell'Ovo, a test of strength to which Dohrn alone proved equal. At last in February, 1874, the Zoological Station was ready for a formal opening, although already a number of investigators had commenced their work. Shortly after this Dohrn married Fräulein Marie von Branowska, the daughter of a friend who lived in Italy. She took a very prominent part in the fulfillment of his ideals. Four sons came from this union, the third of whom, Reinhart, is the successor of his father.

With the finishing of the building and aquaria, there commenced for Dohrn the only less difficult task of equipping the station and providing for its maintenance, so as to meet every possible demand of the investigators working there. At this period his broad view and talent for organization, the tact with which he held in check numberless small difficulties, his restless ambitions, are perhaps more worthy than ever of admiration. It was now necessary to attract young scientists as assistants to the new institution, to educate a personnel to carry on the routine and to establish a regular industry of fisheries. The numberless demands of the often inexperienced investigator had to be learned and satisfied. The habitat of the animals, the times of their appearance and of their maturity, had to be determined, not to mention many other details. This early period of the station presents a happy picture, over which now lies the enchantment lent by distance, blotting out some of the unpleasantnesses.

All was ceaseless activity, as at the advent of spring, and the work grew under the hand of its creator. Early experiences had shown that the station could not properly carry out its functions without a small steamer, and the *Johannes Müller* soon began its successful voyages. But now an imperfect knowledge of the fauna and flora of the bay made itself painfully felt, and in order to gradually remedy this defect Dohrn began the publication of "Fauna and Flora''; to-day an imposing contribution of thirty-three volumes. The desire to have a medium for publishing the briefer records of observation conducted in the station, as well as to give this work publicity, led to the appearance of the *Mitteilungen*. The necessity of procuring for the library all the newest biological literature was the reason for the publication of the *Zoologischen Jahresbericht;* a model of its kind. Soon came countless demands for material for experiment and observation. This led to the development of a new technique for conserving specimens which were supplied to museums in many different countries. The specimens of the wonderful creatures of the sea were most life-like, and the microscopical technique of the Zoological Station was also greatly advanced. The rapidly appearing communications of investigators working there testified to the brilliant way in which the new institute fulfilled the object of its foundation. The head of the station saw without envy how the fruits of his creation even in his own special field of investigation were harvested by others, so numerous were the claims made upon his time from every side, and the greatness of his character is demonstrated by the unselfish way in which Dohrn regarded men of equal strength developing beside him. What he once had confided to well-tried hands, that he now allowed to grow in these same hands and become independent. One name rises to the lips of all here—Lo Bianco. In the porter's lodge of the house in which Dohrn then lived, he had often noticed a boy always usefully busy. Dohrn made use of the fourteen-year-old boy for every kind of small service at the station. In this environment the unusual and very gifted young man grew up to become one of the most important factors in the station, founding and brilliantly directing his own department. Suddenly this powerful figure whose presence can not be dissociated from the Zoological Station, the friend and helper of all working there, has vanished; struck down as by a thunderbolt.

Five years were given over by Dohrn almost entirely to the building and equipping of the Zoological Station. He looked with impatience for the moment when he could return to his own extensive investigations. It is not the wish of this assembly that the importance of Dohrn's scientific achievements should be touched upon in a valedictory; but if it were I, knowing so little of the particulars of Dohrn's special investigations, would refuse the task. As, however, the purpose is to present a character-sketch I can not refrain from attempting to give a picture of the man. When one asks what Dohrn could have meant when he said it was by accident he became a zoologist, I believe we must see in this an expression of the conscious feeling that he was not born a naturalist. The study of his scientific work leads to the conclusion that he did not lack any of the highest attributes of an investigator. He did not, however, possess the elementary desire, the wish, to make observations, to discover new facts known only to the investigator himself. He did not underestimate the value of discoveries, but he was almost indifferent about making them himself. Is it not remarkable that, having opened the shaft leading to the mine of the undiscovered, he did not decide to follow this path? External influences did not determine for him the direction of experiment, but to his own mind problems of a certain kind were presented in theories, which he then tried to prove by known facts. We see that the conceptions he had grasped while in Jena governed the direction of his thought to the end. In his scientific activity he showed himself to be always the same, possessing a restless imagination which presented in anticipation that which he wished to see accomplished. This was bound up with a passionate energy in carrying out what he believed to be right. But these qualities had one effect, when it was a question of reaching a certain goal, and another, when a scientific problem was to be solved. The conception of creating a Zoological Station of the greatest value to science, and the idea that the esophagus of the ancestors of the vertebrates had first passed through the central nervous system, as mental concepts are perhaps not so very different; but in order that these thoughts should actually become productive of results they require elaboration and different attitudes of mind. In the first case a course of action must be followed. The actual achievement leads to the proposed goal. The question of which one is right or wrong has no significance in this connection, other than the idea as to whether the goal is or is not attainable. In the second case there is the question of proving that the course followed corresponds with the one pictured in the imagination. No road is to be made, but one and only one road is to be found. Nothing can stand in sharper contrast than the two ways of working as expressed in the often unrecognized differences between artistic, in its widest sense, and scientific ability. True, both can be found in equally able men, but even in the greatest it seems impossible for one quality to be combined with the other without loss. Dohrn was undoubtedly more a man of the first type. He was impelled to express something personal, as it were, an image of himself. In most expressive words he once described the Zoological Station as an organized work of art which he wished to create. Can such a man in the usual sense of the word be an investigator? Can he who so often found himself a controller of men and situations become a servant such as nature demands of those before whom she is to lay bare her secrets? Did it lie within the power of man to change annelids into vertebrates, possibly Dohrn had been the one to accomplish even this; but that is quite another question.

I wish to call attention to another quality which influenced his scientific productions, and to characterize this in his own words. He writes:

> Without doubt it was, and is a peculiarity of mine to take up a new idea with an apparent partisan blindness. This conception might appear to others absolutely questionable. My lively powers of imagination and the accompanying need of expressing and giving them play might all too easily produce the impression that I looked neither to the right nor to the left, but as it were, hypnotically controlled, saw only in one direction—before me. But in fact this is not the case, thoughtless as I appear, and carelessly as I may express myself, just so easy is it for me, once this craving for expression is satisfied, and the one-sided conception is followed to its utmost limits, to turn about and to follow in an almost diametrically opposite direction, and, if possible, going even further in overthrowing the first conception than my critics.

These words refer to questions of practical usefulness, and I cite them in order to give an example of the self-analysis used by Dohrn. Does not he who knows Dohrn's work read in it the same characteristics? Is not the irrepressible need for expression which must relieve his intellectual tension revealed by writing, before the carefully weighed deliberation upon the other side can come to expression? But notwithstanding the obvious faults connected with his scientific work, the undeniably great personality of the man must be recognized. Dohrn had none of that pride which wishes to write its name in as many as possible of nature's books; his mind was concentrated on one ideal.

Seldom is the scientific life work of a scholar revealed to us so clearly and divided into periods so dominated by motives as that of Dohrn's The beginning is composed of systematic entomological work, inspired by the father's occupations. Arthropods were, therefore, especially well understood by him. Naturally, as a result of Darwin's influence, a change took place in his scientific thought, and he at once applied to the arthropods his phylogenetic theories. In the monograph on pantopoda, published in 1881, the second period terminates. This work proves the fact that through his colossal undertaking, "Fauna and Flora," Dohrn wished to set a good example in a field that was hardly sympathetic to him at the time. Meanwhile he had reached out to grapple with the most important genealogical problem, viz., that of the origin of vertebrates. As early as 1875 in the much-noticed publication, "The Origin of Vertebrates and the Principle of Functional Change," he had outlined the proposed work. And now followed, with the same end in view, "The Studies upon the Origin of the Vertebrate Body," with which Dohrn's twenty-fifth publication came to a close in 1907; before even the greatest part of the mass of introductory work had been completed.

In all these works he is heart and soul historian. Good-humoredly conversing with Momsen, who at first was not favorably disposed to him, Dohrn affirmed that as a matter of fact fundamentally they were working at the same problems. For the zoologist, he maintained, carries on archeological historical studies, but in epochs much more remote than those of so-called ancient history. Again and again in his writings he makes such comparisons as these. The study of man was in reality covered in his studies of vertebrates. His aim was not to erect family trees, but to get an understanding of their growth. No biological law could, in his opinion, have taken the place of genetic observations. He humorously compared the phylogenetic stages with the ancestral picture gallery of a royal castle. To him the epochs were also comparable with the technical models in a museum showing all steps in the development of a steam engine or dynamo. He was convinced, in fine, that both developments—the phylogeny of man and the history of man—must go back to one basic principle. This he believed, even though at the time he had not advanced beyond certain indefinite premonitions. Characteristic of this is his well-known preference for ontogeny in arriving at phylogenetic conclusions as contrasted with comparative anatomy. He was even convinced that he could correctly explain the significance of specific cases and many a heated battle was waged over these opinions. To-day we may allow these debatable questions to lie quiet, for whether or not we grant Dohrn's theoretical standpoint, a saying of Liebig's is justly applicable to him. "One who works is sure to make discoveries, no matter where he starts." What may have appeared to the author, in his effort to reach the ideal, as possibly only his working materials—the great quantity of facts that he brought to light by his untiring application, and the greater improvement of his methods—gave him an honored position among the students of animal morphology; especially in the most difficult of all fields, namely, that dealing with the genesis of the vertebrate head.

Most of Dohrn's publications possess, aside from their subject matter, great literary charm. If we divide, as does Wilhelm Ostwald, investigators into classicists and romanticists, it will be seen from what has already been said that Dohrn was markedly representative of the romanticist type. His works are hardly less expressions of his feelings than of his understanding. He does not present in the least objectively his results, but he lets the reader follow step by step his mental processes to the extent that we see reflected in his works with absolute accuracy the intellectual highly cultivated man keen for battle.

There is no doubt that there were times in which Dohrn estimated his scientific activities as far outweighing in value what he had done for biology through the founding of the station. In such moments he treated the criticism of his scientific opinions with rough injustice, but in this he had the precedent of such great predecessors that it is sufficient to mention the fact only in order to avoid an exaggerated attempt to enhance his character; an effort Dohrn himself would have deprecated. To-day when the sound of battle has passed, those who have run counter to him most sharply acknowledge not alone his great love of truth, but accept the fact that those great outbreaks of a passionate temperament were only the shadow-side of a nature which must have been as it was in order to produce along other lines unequaled and imperishable work.

When one sees how directly and without deviation Dohrn followed his own scientific course, the comprehension he showed of all other branches of biology is doubly remarkable. That he should welcome to the station those engaged in all lines of biological work was a part of the nature of the undertaking. Dohrn had an unusually clear insight into the various fields of our science and of the manner in which they were interdependent and yet complementary to one another. Perhaps the most surprising thing about this apparently one-sided morphologist was the large space dedicated by him to the department of physiology. The addition to the first structure opened in 1888 was planned in order to secure more space for this department and the last great extension, a second time doubling the size of the original building, was put by Dohrn almost exclusively at the disposal of physiologists. This new edifice makes the modest older sister laboratory appear almost in the nature of a step-child. He did not have in mind that physiology for which so much is promised in all modern text-books. Physiology is the knowledge of the vital processes and is divided into physio-physics and physio-chemistry. Before his eyes was a physiology as comprehensive as that conceived of by Johannes Müller, and of which Naegeli once said: "In its Holiest of Holies belongs the origin of the organic world." The time that has elapsed since the founding of the great physiological department is still too short to pass judgment upon the results of this attempt to make physiology breathe sea air. Still even now it can be seen that the close contact which Dohrn established between the study of animal life and development and the exact methods of physiology has stimulated all. His capacity to see, beyond his own field of work and his temporary favorite opinions, the real problem of what life represents and to approach this question from different sides filled the station with a spirit free from all pettiness.

Dohrn was an incomparable host to all his guests. How pleasant it was to meet with him in the library, to pass an evening at his house, or better yet, to sail out with him upon the bay to Cape Misenum or Capri or to his well-beloved Ischia. It was a pleasure to see this man in happy communion with nature, to chat with him seriously, or jokingly, to listen to him as he talked. Of him it can truly be said that nothing human was foreign to his interests, thanks to an almost fabulous wealth of experiences stored up in his ever-impressionable soul. He inherited from his father the love and fine appreciation of music; which was dearest to him of all the arts. Once when an intimate colleague said to him that had he means he would found a picture gallery, Dohrn replied, "And I would own an orchestra led by the best of conductors." While a young man the chance whistling of an air from a violin concerto of Mendelssohn, who, by the way, was his god-father, won for him the sympathy, and later the almost irreplaceable help, of Lloyd, the English aquarium expert; and in later years the road to his heart was most easily found by those with whom he could commune through a common musical taste.

It were vain even to wish to describe the powers of attraction exerted by Dohrn over individuals of widely differing personalities. To the test, "Tell me with whom you associate, and I will tell you who you are," Dohrn could confidently have submitted himself. When, in 1902, an intimate friend among foreign zoologists traveling through Germany, asked a German colleague if he often saw Dohrn, the reply was: "We never see Dohrn any more, he associates entirely now with princes, excellencies and millionaires." In this joking exaggeration is hidden a real and at the same time an important side of Dohrn's relations with people, important alike for the station and zoologists. When he began the building of his zoological station and knocked now here, now there at the doors of the well-to-do, asking if they were not inclined to make some offering in the interests of science, he found, with few exceptions, wise councils, but no money. One notable exception was a gift from English scientists led by Darwin, Lyell, Huxley and Lubbock. Nothing better illustrates the position he finally won for himself than the fact that thirty years later not only did the city of Naples again cede to him a most valuable piece of the public garden, for the station's new building, but above all he erected this building with funds placed at his disposal without conditions by rich friends. And so great was the consideration and confidence he enjoyed that without the least difficulty he could have obtained even greater sums, without specifying "the why or wherefore." But at first, as we have already said, his requests for aid brought only disappointment, and it would have gone hard with the station had not the personal impression he so well knew how to make on ministers and ambassadors and leading members of the Berlin Academy and the Reichstag led to a spirit of readiness to grant support; an accomplishment which compels us to marvel when we consider the caution and the typical reaction of inertia such appeals usually evoke. But quite as necessary as material means for the success of this undertaking planned by a German on Italian soil, was the awakening of an Italian sentiment and the moral support of the fatherland. Highly as we may estimate the spontaneous interest in zoology of the German and Italian rulers, it is beyond question that this sympathetic interest was stimulated by Dohrn's personal qualities and by the turn that his creative faculty could give to the methods for carrying on zoological investigations. The gain to the station coming from this powerful protection needs no comment.

When I spoke of Dohrn's social affiliations I had something special in mind: From his earliest years until his death he maintained the closest ties of friendship with men of the highest intellectual standing entirely regardless of material conditions. I mention only those who are dead, and whose names are widely known: one of the most notable zoologists, Thomas H. Huxley; the eminent physicist and founder of the Zeiss works, Ernst Abbé; the gifted inventor, Werner von Siemens; Robert von Keudell, ambassador, distinguished in mind as in character; the great musician, Joseph Joachim; and the painter, Hans von Mareés, who at last, after long neglect, is receiving recognition, are enough to prove to us what a noble and rich nature Dohrn must have had. Without these mental qualities would it have been conceivable that he could have won and kept for the station such remarkable professional associates at a time when the future of his creation and of these young men was still unknown? And this attachment of his fellow workers is so much the more remarkable as there were times when the attempt to work with Dohrn was no easy task; but even then the essential element of Dohrn's nature shone out through the mist, so that even the simple fisher-folk were able to appreciate it. Underneath the overbearing character of a nature born to command they were able to recognize a kindly personality in whose hands they knew themselves to be secure. With faithful devotion they hung upon their "Signor Dohrn," and whatever he might have demanded of them each and all would have obeyed.

Fragmentary as is the picture, it were incomplete in a most important point should a subject I have just touched upon remain unexpressed; namely, that the shadow-side as well was not lacking in this wonderfully successful life. Already in the beginning of the early seventies the periods of his greatest development of strength were broken by times of such deep nervous depression that all the remarkable qualities which distinguished Dohrn on other days then seemed almost to disappear. He himself attributed the origin of this affliction to his mother's family, but the indescribable fatigues and condition of mental tension under which he lived were sufficient to explain the occurrence even in a very strong constitution, of these periods of complete exhaustion. Much as he enjoyed his life in a foreign land, this exile brought a great deal that was painful. Dohrn's was one of those natures which, while fully conscious of their achievement, look upon that which is finished almost as the work of another, and hence again and again feel impelled to prove their right to live by new deeds accomplished. Thus the latter years of his life were almost a continual torment to this man of action, for his bodily strength could not keep pace with the still active spirit. Yearly, physicians sent the rebellious man northward, over the Alps, for months at a time. And like Albrecht Dürer, who after only a short journey in Italy sighed at parting, "wie wird mich nach der Sonnen frieren; hier bin ich ein Herr, daheim Schmarotzer," so exclaimed Dohrn as he left his life-work behind him.

To linger awhile in the world of his own creation, and to sail once again in his well-beloved boat out upon the blue waters, was his last wish; but before it could be realized, he died suddenly in Munich on the twenty-sixth of September, 1911.

When I undertook the task of speaking to you of Dohrn, I asked myself which one of his qualities was it above all others that gave birth to the wish to honor his memory before an International Zoological Congress. Scientific achievement alone, as far as I know, has never prompted such an honor. If one should say in Dohrn's case it was the influence exerted on collective achievements, the instance might be paralleled by Abbe's improvements on the microscope. Those, although in a different way, were not less far-reaching in their effect on the development of biology, but as a result of this accomplishment it does not follow that a congress of zoologists should feel prompted to recognize publicly such great services. The answer, I believe, is not hard to find. We honor in Anton Dohrn not only his prodigious achievements, but his marvelous insight that affects us so directly as zoologists. The zoological station was planned and carried on with the comprehensive realization of the importance of that place in the development of our science which it would be called upon to fill. And the more intimately we are acquainted with the early years of its history, the clearer does it become that for such a work a man was necessary in whom special and unusual qualities were combined; sometimes even partially contradictory ones. We feel the unprecedented and peculiar fitness of this personality for the work. As the man who accomplished this achievement undertook it in the service of a great cause, perfectly conscious that he must risk time, strength and health, yes all he had and all he held most dear—his figure takes on for us something of the great and heroic. But even in these immaterial things we find a law of compensation. Whatever a great man by untiring and unselfish devotion puts into his work as the result of the love of his profession, that is reflected in the labor itself. That which Anton Dohrn, impelled by the noblest of creative impulses, has done for all of us now compels us to honor him by an expression of admiration and gratitude that will hallow his memory through many years to come.

No more suitable occasion to express this could offer than the International Congress. In recent years it would hardly be possible to find a man more entitled to be considered as an international personality, and it is not necessary to explain more fully than has been done the peculiar applicability of this term to Dohrn. Those who knew him realize that he neither could nor would deny the race from which he sprung. He had a deep love of his country and he cherished a feeling of loyalty, thankfulness and duty to the land in which his being, physical and spiritual, had its roots. An excessive national pride or conceit was entirely foreign to him. The dispassionate impartiality with which in quieter moments he was able to analyze himself enabled him to compare the defects and advantages of his own with other nations. He was able, as many were not, to sympathize with the feelings of others for their own country. He not only understood, but enjoyed the traits of Italians, as well as of the English and Americans. He understood how to learn something from all, and to many he was bound by ties of intimate friendship; and when it was a question of science only, then all barriers disappeared. Was it not from beginning to end his dominant desire to realize in the Zoological Station not only one of the most favorably conditioned places for work, for all biologists, but above all to create a common center in which the one-sidedness of isolated scientific work could be equalized? How often has he said that the station represented, as it were, a continuous zoological congress. Every one who has worked long or often in Naples must have felt this. Not only have numberless acquaintances and friendships arisen between the investigators of different countries, not only has there been an interchange of views, a discussion of work and of methods, but almost all who have worked in the station have consciously or unconsciously left behind them parting gifts from their scientific possessions which, gradually growing to a store of incalculable value, are put at the disposal of all those who follow and thus insensibly aid in the ever widening and increasing usefulness of the station.

Of all the many inspirations of Dohrn, undoubtedly one of the happiest was the subsidizing of the station by the introduction of his table-system, thus making the institution international. Only in this way was it possible to keep the organism free from the dry husks of state tutelage, and to give it sufficient flexibility to meet new conditions, at the same time protecting it from the inertia springing from self-satisfaction or the possibility of retrogression by the ever-recurring necessity for meeting these needs.

But we must also take into consideration the reverse side of such fully adjusted reactionary capacities: its vulnerability. And here is the point at which our passive feeling of gratitude can be changed into active assistance. Every biologist, convinced that the Naples station, on account of its position and size, its catholicity of spirit and richness in opportunities for work, and, not least of all, because of its international character, is of inestimable value for our science, may, by openly giving expression to this belief, help to perpetuate the work as planned by its founder. Let us look upon this institution as a legacy from Dohrn which he has confided to the care of each one of us.

Even though we must grant that such a valedictory as this fails in its chief aim, as he in whose honor it is pronounced can not hear it, we must console ourselves with the thought that the men among whom Dohrn lived had not left him in doubt as to the esteem in which they held his work. Few men in our profession have been recipients of such honors as were shown him by princes and governments, by academies and faculties, from the city in which he worked, and from biologists all over the world, as were shown him during the station's jubilee celebration. Even more precious may have been to him the many spontaneous expressions of sincere admiration and grateful devotion. At the last International Congress such marks of appreciation were shown as to move him deeply, and even without all this he had only to reflect to become conscious of the fact that he had given an impulse to biology which could be equaled only by very few, and that his deeds and his name would continue to shine in the history of our science far above, where only the highest summits are visible. We zoologists will take pleasure in the thought that Anton Dohrn belonged to us.

Theodor Boveri
University of Wurzburg

THE SCIENTIFIC WORK OF MISS N. M. STEVENS

Miss Stevens began her career as an investigator in 1901 at the age of forty years. It is rare for one who starts so late in life to attain in a few years so high a rank amongst the leaders in one's chosen field. In Miss Stevens's case this was made possible by her natural ability and devotion to her work, as well as by the liberality of Bryn Mawr College, which created for her a research professorship. Her investigations lay almost entirely in the field of cytology, and covered not only extensive studies of the germ cells, but a memoir on the life cycle of one of the protozoa, and several papers on the histology of regenerative processes in planarians and hydroids.

Modern cytological work involves an intricacy of detail, the significance of which can be appreciated by the specialist alone; but Miss Stevens had a share in a discovery of importance, and her name will be remembered for this, when the minutiæ of detailed investigations that she carried out have become incorporated in the general body of the subject. In 1906 she found that the male of a beetle (*Tenebrio molitor*) produced two kinds of sperm, differing in that one half the sperms have a large chromosome and the other half a smaller chromosome. Two such classes of sperm were already known in certain other insects, and McClung had earlier suggested their connection with sex production. Miss Stevens was among the first to establish the correctness of this hypothesis by the discovery that the small chromosome is confined to the male line while in the female its place is taken by the larger one. She drew the correct inference that since all unfertilized eggs are alike in their chromosomal content, therefore a female results from the fertilization of an egg by the sperm containing the larger chromosome, and the male by the sperm containing the smaller chromosome. A similar relation was discovered at the same time by Professor E. B. Wilson. Their joint discovery marks the turning point in the history of the theory of sex-determination.

During the following six years Miss Stevens extended her studies in this subject over a wide field. In 50 species of beetle she found an unpaired chromosome in twelve cases, and an XY pair in thirty-eight cases, and in nine species of flies she found an XY pair of chromosomes. Such an extensive study will not seem superfluous when the reception of this important discovery in regard to sex is remembered, for the profound significance of the results were by no means generally appreciated, and it is not going too far to say that many cytologists assumed a sceptical or even antagonistic attitude for several years towards the new discovery. No doubt this will be attributed to scientific caution, but conservatism may better account for the slowness with which a recognition of this discovery was received. It was said, for example, that the unequal distribution of the sex chromosomes is only an index of some more profound changes taking place, and is not in itself the real differential. In apparent support of this objection was advanced the fact—which Miss Stevens's work had also helped to establish—that in a number of insects the sex-chromosomes are equal in size. The first objection is purely formal, for even if true the discovery would still remain of prime importance as indicating when and how an internal difference arises that leads to the formation of the two sexes. In regard to the fact appealed to in apparent support of this objection, it has, more recently, become apparent that the sex chromosomes are also responsible for a number of other differences, in addition to that of sex determination. In other words, sex determination is only one of many "factors" carried by these chromosomes. If this is granted, the inequality in size differences—one on which perhaps too much emphasis was placed at first—is in itself of no significance, although when such a difference is present it gives a clue to a fundamental relation which might otherwise escape detection. The appeal, therefore, to the cases where no difference in size can be detected, has no significance, except in so far as an unfortunate emphasis laid on a size difference gave the conservative-minded an opportunity to insist on an unimportant criticism.

Miss Stevens's first paper in 1901 gave a complete account of the life cycle of the protozoan, *Boveria,* parasitic in Holothurians. Later she discovered the occurrence of true chromosomes in this form, and made out many of the processes that take place during conjugation.

Four papers dealing with the chromosomes in the life cycle of Aphids appeared in 1905, 1908, 1909 and 1910. The double number of paired chromosomes was found in the parthenogenetic cycle, and the reduced number in the sexual forms. The parthenogenetic eggs were shown to give off a single polar body; the sexual egg two polar bodies. Miss Stevens denied at first the presence of an unpaired sex chromosome in the spermatogenesis, but later corrected this error. She failed to note, at first, that the male had fewer chromosomes than the female, but later recognized this difference. In her work on other insects she described both an end-to-end union of chromosomes, as well as a side-to-side pairing, but her work on the synaptic stages was far less complete and convincing than that on other parts of the germ-cycle. At the time of her death she was engaged in studies directed more especially to this difficult phase of gametogenesis.

She discovered in the Muscidæ that the homologous chromosomes lie side by side in each spermatogonial and oogonial division, as well as before synapsis. Even in somatic division a similar pairing was found. In *Ceuthophilus* one to three supernumerary chromosomes were discovered, whose behavior in rest and in growth stages indicated, she thought, their probable relationship to the sex chromosomes (1912). Previously, she has found that the presence of supernumerary chromosomes in *Diabrotica* led to a variable number (with fixed limits however) of chromosomes in different individuals of the same species.

In the regenerative processes in the hydroid, *Tubularia,* Miss Stevens found that the old tissues become remodeled into the new without undergoing any retrogressive changes, and a similar condition was found in Planarians. In *Sagitta* the true oviduct, previously overlooked, was described and its development, and that of the ovary also, were thoroughly studied.

Some interesting facts in regard to the color of the parthenogenetic and sexual forms of Aphids were recorded, but the study of the inheritance of these colors was not brought to completion, although certain possibilities were indicated. Miss Stevens's experimental work was much less extensive. It included studies on the regeneration of hydroids and planarians. She performed the delicate operation of separating the centrosome from the rest of the karyokinetic figure with the eggs of the sea-urchin. The non-nucleated piece, with a centrosome but without a nucleus, was found not to divide further, confirming Boveri's conclusion that the centrosome alone is unable to bring about cell division.

Miss Stevens's work is characterized by its precision, and by a caution that seldom ventures far from the immediate observation. Her contributions are models of brevity—a brevity amounting at times almost to meagerness. Empirically productive, philosophically she was careful to a degree that makes her work appear at times wanting in that sort of inspiration that utilizes the plain fact of discovery for wider vision. She was a trained expert in the modern sense—in the sense in which biology has ceased to be a playground for the amateur and a plaything for the mystic. Her single-mindedness and devotion, combined with keen powers of observation; her thoughfulness and patience, united to a well-balanced judgment, accounts, in part, for her remarkable accomplishment.

T. H. Morgan

THE SCHOOL OF JOURNALISM OF COLUMBIA UNIVERSITY

Talcott Williams, director of the School of Journalism in Columbia University on the Pulitzer Foundation at the formal opening of the school at Earl Hall, September 30, spoke in substance as follows:

The School of Journalism opens, within a year of the death of Joseph Pulitzer whose endowment rendered this training for the newspaper man possible, with about a hundred students. They represent 21 countries and states, including China and New Zealand. Less than half are from New York state. In the first year one half are men who have had newspaper experience and all these left wage-earning positions to enter the school. One fifth of those in the school hold college degrees, a proportion far larger than when law and medical schools first opened. Of the 100 pupils entering, nine are women, a proportion of women less than that which exists in journalism, taking all newspapers and periodicals. Of the teaching force, 24 in number, 8 or one third have had practical experience in journalism and four have given nearly all their active lives to this calling.

In America great changes are worked by wide discussion. The first fruits of the school are that before it opened, the newspaper discussion for six months past, jointly due to its great endowment and the action of Columbia University in accepting it, had proved public conviction of the need of training for newspaper men and the demand and support of the newspaper press, as a whole, for this professional preparation. This public verdict has quickened the interest, both of the public and the universities in this field. The question is no longer, as it was half a year ago, whether journalists shall be trained, but how they shall be trained so as to become efficient journalists better able to serve the public.

Under the foundation men of experience, ability and maturity are admitted to the school without an examination and after two years of adequate work are eligible to the degree offered by the university on the completion of the course. This opportunity to gain a college degree without the usual requirements for matriculation has attracted a large number of applicants, but they have been rigorously sifted, none accepted unless they showed a special capacity for journalism, and 17 have been admitted.

The training of the School of Journalism in Columbia University through its four years' course divides itself between studies on history, law, government, party organization, economics, unions, trusts and literature, training in reporting and training in writing. The first two years are devoted to the fundamental studies whose knowledge is necessary to the journalist in his work. Men intending to be journalists who have not had a college education are strongly advised to take these two years, if they are unable to take the full course. They are crowded with the studies which will aid a man's future work in journalism. These studies are immediate and deal with the issues and events of to-day. The entire course is made up after consultation with and the approval of a group of the ablest journalists in the country.

Nearly one third of the time in the course is given to training in writing. The students will do nearly as much writing each week as the average man in a newspaper office. This work will be rigorously corrected and required to be punctual as on a newspaper and will be done under a time limit, as in service condition. Training in writing in the school looks to accuracy, presentation and a vivid style. In this training, the customary place in college "English" of "themes" and subjects, created for the occasion, is laid aside and the subjects on which men write spring either from their studies or from their work as reporters. Political science at the opening of the present year, in the first-year class, is devoted to the presidential election. In the second year, economics will be studied in the usual beginning course; but weekly, the pupils will write under direction a "business article" reviewing the business and financial week, such as many newspapers publish Saturday, Sunday or Monday. History will furnish subjects cast in newspaper form in the shape of despatches from historic battlefields, reports of historic events and estimates of public men and measures, treated in the editorial spirit. Throughout all the studies this plan will be adopted and both science and literature will be used to supply subjects training men in treatment and presentation.

The news of New York will be employed in the last two years to train men in reporting, to school them in writing and to acquaint them with the life of a great city. Trials, the visit of the battleships, the election, where the returns will be handled, large events and small will be used as assignments. The manifold copy ("tissue") furnished newspapers will be employed in editing copy and in building head lines. The presidential campaign will furnish a text for editorial writing, new plays will be the subject of notices, the exhibition of the Academy of Design of art criticism and new books of book reviewing.

When the women who have now entered for the first year reach the third and fourth year in this course, those who desire to prepare for the woman's page will be given the opportunity in connection with the School of Household Arts in Columbia University. Already students in the fourth year in the school are selecting studies in sociology intended to lead to special fields of writing, but of all students reporting is required, as the basis of the newspaper man's training.

This combination of exact study in the structure of the state and its action in history, administration, party organization and economics, combined with accurate reporting and graphic writing has not yet been attempted on the same scale and under such favorable conditions. It is planned by newspaper men, it is taught by newspaper men, and it reproduces newspaper conditions in order to train the newspaper man.

BRITISH ASSOCIATION GRANTS FOR RESEARCH

At the Dundee meeting of the British Association grants for research amounting to over $5,000 were made as follows:

Professor H. H. Turner, seismological observations, £60; Dr. W. N. Shaw, upper atmosphere, £50; Sir W. Ramsay, grant to the International Commission on Physical and Chemical Constants, £40; Professor M. J. M. Hill, tabulation of Bessel functions, £30; Dr. W. H. Perkin, study of hydro-aromatic substances, £20; Professor H. E. Armstrong, dynamic isomerism, £30; Professor F. S. Kipping, transformation of aromatic nitroamines, £20; A. D. Hall, plant enzymes, £30; R. H. Tiddeman, erratic blocks, £5; Professor W. W. Watts, igneous and associated sedimentary rocks of Glensaul, £10; Professor P. F. Kendall, list of characteristic fossils, £5; Dr. J. Horne, Old Red Sandstone of Dura Den, £75; Dr. A. Strachan, Ramsay Island, Pembroke, £10; Professor Grenville Cole, Old Red Sandstone of Kiltorcan, £15; Professor S. J. Hickson, table at the Zoological Station at Naples, £30; Dr. A. E. Shipley, Belmullet Whaling Station, £15; Dr. Chalmers Mitchell, nomenclator animalium genera et subgenera, £100; Sir W. H. Preece, gaseous explosions, £80; Dr. R. Munro, Glastonbury Lake Village, £5; C. H. Read, age of stone circles, £2; Dr. R. Munro, artificial islands in Highland lochs, £5; Professor G. Elliot Smith, physical character of ancient Egyptians, £34; Professor A. Thomson, anthropometric investigations in British Isles, £5; Professor W. Ridgeway, Roman sites in Britain, £15; Professor W. Ridgeway, excavations in Macedonia, £30; E. S. Hartland, Hausa manuscripts, £20; Professor E. A. Schäfer, the ductless glands, £40; Professor S. J. Hickson, table at the Zoological Station at Naples, £20; Professor J. S. Macdonald, calorimetric observations, £45; Professor Starling, oxyhemoglobin, £15; Professor F. Gotch, mammalian heart, £20; Dr. D. H. Scott, structure of fossil plants, £15; Professor A. C. Seward, Jurassic flora of Yorkshire, £15; Professor F. Keeble, flora of peat of Kennet Valley, £15; A. G. Tansley, vegetation of Ditcham Park, £45; Professor J. J. Findlay, mental and physical factors, £20; Dr. G. A. Auden, influence of school books on eyesight, £15; Sir H. Miers, scholarships, etc., held by university students, £5.

SCIENTIFIC NOTES AND NEWS

Dr. Lewis Boss, director of the Dudley Observatory, Albany, since 1875, and director of the department of meridian astronomy of the Carnegie Institution, died on October 5, aged sixty-six years.

Professor Morris Loeb, the distinguished chemist of New York City, died on October 8, aged forty-nine years.

The Huxley Lecture will be delivered at Charing Cross Hospital Medical College on October 31 by Dr. Simon Flexner, of the New York Rockefeller Institute. The subject he has chosen is "Recent Advances in Science in Relation to Practical Medicine." Previous lecturers have been Professor Virchow, Lord Lister, Professor Welch, Professor Pavlov, Sir Patrick Manson, Sir William Macewen and Dr. F. W. Mott.

Professor Mary W. Whitney, director of the Vassar College Observatory since 1888, retires on a pension of the Carnegie Foundation as professor emeritus of astronomy.

Professor H. J. Wheeler, former acting president of the Rhode Island State College, at Kingston, R. I., and for eleven years director of the government agricultural experiment station at that institution, has tendered his resignation.

Dr. M. W. Haskell, professor of mathematics in the University of California, has received a half-year's leave of absence, which he is spending abroad.

Dr. David H. Tennent, professor of biology at Bryn Mawr College, has returned after a year's leave of absence spent partly in the Bahama Islands and partly at Naples.

Dr. Frederick H. Getman, associate in physical chemistry at Bryn Mawr College, has been granted a leave of absence for the academic year.

Professor Santayana, having resigned from his chair at Harvard University, and Professor Royce being on leave of absence for the whole year and Professor Palmer for the second half, there will be no full professor in service on the side of pure philosophy. Professor Bakewell, of Yale University, will come up from New Haven to give instruction during part of each week.

Dr. Neil E. Stevens, recently assistant pathologist in the Kansas Experiment Station, has accepted a position as forest pathologist in the Bureau of Plant Industry.

Professor Rudolph Eucken, of the University of Jena, visiting professor at Harvard University, has been selected to deliver the Deems lectures at New York University this year. They will be six in number, and will be given in the English language, probably in February or March of next year. The subject of the course will be "The Fundamental Principles of Ethics with special Consideration of the Religious Problems."

Professor Morris Jastrow, of the University of Pennsylvania, has been appointed Haskell lecturer on oriental literature in Oberlin College.

Among public lectures being given at the University College, London, are the following: Professor Flinders Petrie, on "Amulets"; Professor G. Dawes Hicks, on "The Philosophy of Shadworth Hodgson"; Mr. D. Jones, on "General Phonetics"; Mr. Carveth Read, on "An Introduction to Comparative Psychology"; Professor H. E. Butler, on "Roman Education"; Professor F. W. Oliver, on "Joseph Dalton Hooker," and Professor J. A. Fleming, on "The Sources of Energy Available to Man."

A memorial to Lord Lister is to be established at University College Hospital. It was in 1843 that Joseph Lister entered the college as an arts student and graduated bachelor of arts in 1847. He then became a student of medicine and entered the hospital to complete his studies. A special committee has been formed under the presidency of the Duke of Bedford, president of the hospital. The exact nature of the tribute will be largely decided by the amount of the subscriptions received, but it has been suggested that either a bust or a tablet should be placed in both the hospital and the college. It is understood that the memorial will be entirely local in character, and only those who have been in some way connected with University College or the hospital are being asked to subscribe.

A tablet in memory of Dr. Walter Reed, eminent for his work in yellow fever, will be erected at the University of Virginia by the Virginia Medical Association.

Naval constructor John Forsyth Hanscom, U. S. N., retired, an authority on naval construction, died on September 30, aged seventy years.

A Reuter telegram from London (Ontario) states that Mr. Stewart Dickey, of Belfast, Ireland, who recently arrived there to take up the position of professor of anatomy at the Western Medical College, has died in circumstances pointing to suicide.

Mr. G. H. Grosvenor, an entomologist connected with Jesus College, Oxford, who was assistant secretary of the recent International Entomological Congress, has been drowned off the Cornish coast in trying to save the life of a poor swimmer.

The fifth annual meeting of the American Institute of Chemical Engineers will be held in Detroit, Mich., from December 4 to 6, 1912. A number of the technical plants in and about Detroit will be visited and a program of papers and addresses will be presented.

At the eighty-fourth meeting of the German Association of Scientific men and Physicians held recently at Münster, it was decided that next year the meeting will be held at Vienna, under the presidency of Professor H. H. Meyer.

The first Italian Congress on the history of medicine and natural science will be held in Rome from October 11 to 14.

Two of the commissions appointed by the official standing committee of the International Meteorological Association have been in joint conference this week at the Meteorological Office, London, under the chairmanship of the president of the committee, Dr. W. N. Shaw. They have discussed the questions of securing uniformity of practise in storm signalling, and of revision of the telegraphic code for the interchange of information.

Dr. Alfred Ackermann, of the publishing house of B. G. Teubner, has presented the sum of 20,000 Marks to the University of Leipzig, to establish the "Alfred Ackermann-Teubner memorial prize for the promotion of the mathematical sciences."

The Nantucket Maria Mitchell Association offers an astronomical fellowship of one thousand dollars, to a woman, for the year beginning June 15, 1913, under the following conditions: The year shall be divided into two periods, approximately as follows: June fifteenth to December fifteenth on Nantucket. This period shall be occupied in observation, research or study, and in lectures or instruction to classes or individuals. February first to June fifteenth at one of the larger observatories. This semester shall be occupied in original research and study. During this period a distinct plan for the following Nantucket period shall be formulated. Every fourth year the fellowship shall be available during the entire year for study at a larger observatory. The fellowship will be awarded annually, but in order that the work at Nantucket may be combined advantageously with the work at the selected observatory, the preference will be given to the same candidate for three successive years. This candidate shall have first consideration among applicants for the special quadrennial appointment. A competitive examination will not be held. The candidate must present evidence of qualifications. The Nantucket Observatory is equipped with a five-inch Alvan Clark telescope and a micrometer for measuring stellar spectra. The Astronomical Fellowship Committee proposes to add such equipment as will enable the fellow to make a special study of asteroids. The proposed plan has been approved by Dr. Edward C. Pickering and Miss Annie J. Cannon, of Harvard Observatory, and will be carried out as soon as practicable. Application for the year beginning June 15, 1913, should be made under the above heads, and must be in the hands of the secretary of the committee, Mrs. Charles S. Hinchman, 3635 Chestnut Street, Philadelphia, Pa., on or before March 1, 1913.

A letter received at the Harvard College Observatory from Professor E. E. Barnard, of the Yerkes Observatory, states that the spectrum of Gale's comet obtained by Mr. J. A. Parkhurst with the objective prism on the UV Zeiss camera, September 30, 1912, 7 p.m., shows only two bands: the fourth carbon band at λ 4711 and the third cyanogen band at λ 3883. The continuous spectrum was weak. There was a slight indication of strengthening at a greater wave-length than 4711, but the exposure was necessarily short, and nothing definite in this region could be seen. Exposures with the Bruce photographic telescope on September 29 and 30 show a faint, slender tail, 4° long. Though bright in a 5-inch telescope, the comet was not visible to the naked eye. The comet was also seen by Mr. E. L. Forsyth at Needles, Cal., on September 25, and by Professor Anne S. Young, at South Hadley, Mass., and Mr. Frederick C. Leonard, at Chicago, Ill., on September 30.

A special number of the *Atti della R. Accademia dei Lincei* contains the report of the proceedings at the anniversary meeting last June. According to *Nature* it announces a gift of £4,000 from Dr. Gino Modigliani towards the publication of the works of Leonardo da Vinci, and a legacy to the academy of £2,000, as well as of many of her personal effects, from the estate of the late Signora Celli Dutuit. Prizes given by the King of Italy have been awarded to Professor Ernesto Manasse for mineralogy and geology, and to Professor Giuseppe Chiovenda for jurisprudence and political science. The minister of public instruction also gives four prizes, each of which has this year been divided, the recipients being Professors G. Ercolini and A.

Amerio for physics, Professors A. Quartaroli and R. Salvadori for chemistry, and Professors Enrico Carrara, Donadoni Eugenio, Levi Ezio and Ribezzo Francesco for the two philology prizes. A prize founded by Santoro is awarded to Professor Costantino Gorini for his discoveries in the bacteriology of cheese, while another most useful prize, founded by the late Alfonso Sella for assistant lecturers in the department of physics, is awarded to Dr. Paolo Rossi, of the University of Naples.

The *Geographical Journal* states that an elaborate expedition is being organized in Germany by Lieut. Schröder-Stranz, whose original intention of carrying out a voyage of research to Novaya Zemlya and the Taimur peninsula has now given place to a proposed complete circumnavigation of northern Europe and Asia, repeating the classic achievement of Nordenskjöld in the *Vega*. Lieut. Schröder-Stranz is not, however, desirous of merely once more achieving the passage after an interval of thirty-four years, but hopes to carry out extensive scientific researches during the voyage, which is expected to last from three to four years. On the Russian side, it appears that Mr. Russanof, who has many times visited the Novaya Zemlya region, is once more planning an expedition to that country, with a view to further testing the possibilities of navigation to Siberia round its northern end. He will be accompanied by Mr. Kuchin as hydrographer. On the other hand, it is said that the opening of a sea-way to Siberia from the west does not find favor with the Russian authorities, who, however, are continuing their efforts to open regular navigation from Bering Sea to the Kolyma and Lena Rivers. The mouth of the former river is to be surveyed by Captain Grünfeld, who has already started from Yakutsk for the purpose, while the stretch of coast-water between the Kolyma and Lena is to be investigated by the well-known geologist, J. P. Tolmachef. A good deal has been heard of a proposed Russian expedition to the North Pole, under Lieut. Sedof, who has already undertaken minor expeditions to northern Siberia and Novaya Zemlya. Sedof's plan appears to be to proceed to Franz Josef Land, and thence make a sledge journey across the pole to northern Greenland. It is reported, however, that the hoped-for support of the Russian government is not likely to be afforded, and the venture must rely on private assistance only. On the Greenland side the explorer Rasmussen has prosecuted his plan, abandoned last year from force of adverse circumstances, and found traces of the missing Danish explorer, Einar Mikkelsen.

The Italian Commission for the survey of the frontier of Italian Somaliland with Abyssinia returned to Italy in January, and some account of its operations is given in the *Geographical Journal* from *Revista Geografica Italiana*. The leader was Captain Carlo Citerni, one of the survivors of Bottego's last expedition, who was supported by Dr. B. Colonna as medical officer, and by Signors Grupelli and Venturi as topographers. The expedition set out towards the end of 1910, traveling from Jibuti to Adis Ababa, whence it was to strike southeast through an imperfectly known country to Dolo on the upper Jub, a little above Lugh. Here the survey of the frontier was to begin. During the stay at Adis Ababa a topographical survey of about twelve square miles was carried out on the scale of 1:25,000, embracing the city and its environs. The march to Dolo led by the Lagio pass from the basin of the Hawash into that of the Web, across a mountain range with summits reaching 13,000 feet and more. At Dolo observations for latitude, longitude and azimuth were taken and a base measured, after which a triangulation was carried out along the frontier zone to the northeast and a survey plotted on the scale of 1:100,000. This region had hitherto been almost a blank on the map. The work does not seem to have been continued beyond the Webi Shebeli, but on reaching this the commission returned to the coast at Brava. Besides the precise survey of the frontier, a careful traverse of the whole route from Dire Dawa (near Harrar) to Brava was carried out, and numerous astronomical determinations of latitude and longitude were made.

UNIVERSITY AND EDUCATIONAL NEWS

Mrs. Radcliffe Crocker has made a gift of £1,500 to University College Hospital to endow a traveling scholarship in dermatology in memory of her husband, Dr. H. Radcliffe Crocker, for 30 years physician to the hospital. The scholarship carries with it a gold medal, and will be awarded every five years.

In a note reprinted in Science on the number of degrees conferred by a number of American colleges and universities, Cornell University was omitted. This university conferred in 1912, 918 degrees, in 1911, 814 degrees, and in 1902, 496 degrees.

A complimentary dinner was given by President Charles F. Thwing, of Western Reserve University, at the University Club, Cleveland, on Thursday evening, October 3, in honor of students winning honors and prizes by high scholarship in Adelbert College. President Thwing's guests included twenty-nine students.

Dean Woods, of the department of agriculture of the University of Minnesota, recently declined an offer of $9,000 to become head of the agricultural department of the University of California. The regents of the University of Minnesota voted to increase his salary to $7,500.

Dr. John Fraser, assistant professor of chemistry in the University of Pennsylvania, has been elected dean of the Towne Scientific School. His father and his grandfather were both distinguished professors of chemistry in the University of Pennsylvania. Dr. William Pepper, whose appointment as dean of the medical school, has already been announced, is the son of Dr. William Pepper and the grandson of Dr. William Pepper, both of whom were distinguished professors of medicine in the university.

Professor George Herbert Palmer, Alford professor of natural religion, moral philosophy and civil polity, will be the Harvard exchange professor with the four western colleges. His term of service will fall in the second half year. The officers who will come from the western colleges in the exchange are Professor D. E. Watkins, from Knox College, Galesburg, Illinois, who will teach in the department of public speaking through the year; Professor P. F. Peck, of Grinnell College, Iowa, who will give instruction in American history in the second half year, and Professor G. H. Albright, of Colorado College, who will give instruction in mathematics. Beloit College, Wisconsin, has not yet chosen its exchange professor.

At the University of Pennsylvania Clarence Erwin McClung, Ph.D., now professor of zoology in the University of Kansas, takes the chair made vacant by the death of Dr. Thomas H. Montgomery, Jr. Robert Heywood Fernald, of the Case School of Applied Science, succeeds the late Professor Henry W. Spangler as professor of dynamic engineering.

Professor John Alden Ferguson, head of the Forest School of the University of Missouri, has returned to the Pennsylvania State College, as head of the Forest School.

Professor Olin Ferguson, of Union College, has become head of the electrical engineering department at the University of Nebraska. His place at Union College has been taken by Professor Walter L. Upson, of the University of Vermont.

Dr. Edna Carter, holder of the Sarah Berliner fellowship at the University of Würzburg in 1910–11, returns to Vassar College as associate professor in physics.

Professor O. A. Johannsen, formerly entomologist of Maine Station at Orono, has returned to Cornell University to teach in the department of biology.

To fill the vacany caused by the appointment as full professor of organic chemistry at Harvard University of Professor Elmer P. Kohler, who has been connected with Bryn Mawr College for twenty-one years, Dr. Roger F. Brunel, A.B. (Colby), Ph.D. (Hopkins), has been called from Syracuse University.

Dr. Lewis William Fetzer, of the United States Office of Experiment Stations, has been elected associate professor of chemical physiology in the State University of Oregon Medical College at Portland. The Oregon physiological laboratories are now officered by John D. MacLaren, M.S., M.D., director; L. W. Fetzer, Ph.D., M.D., physiologic chemist; Horace Fenton, A.B., M.D., clinician; Mary V. Madigan, M.D., anesthetist; O. W. Curran, Ph.B., assistant, and J. C. Rinehart, B.S., technician.

DISCUSSION AND CORRESPONDENCE

ONE PHASE OF WASHINGTON SCIENCE

In a presidential address[1] before the Geological Society of Washington, Mr. Alfred H. Brooks has reviewed the evolution of applied geology and sought to point out the relation of the material condition of mankind, the address throws an interesting but perhaps wholly unintended side-light upon one phase of "Washington Science."

The address may be said to constitute both an apology for and a glorification of the almost complete exclusion of pure science from the later work of the United States Geological Survey, and the attempt is further made to show that a like metamorphism has characterized the work of our American universities during the last two decades. The concluding sentences of the address, if taken alone, might indeed seem to contradict the earlier statements of the report. They are worth quoting:

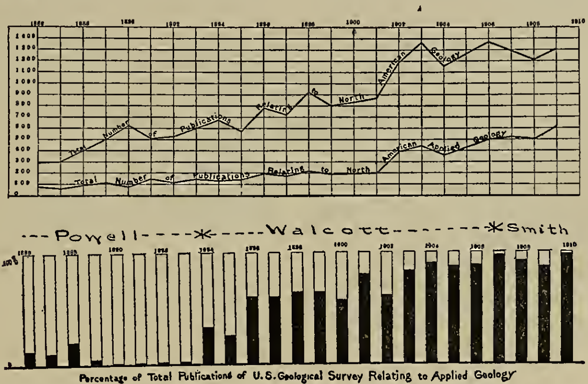

Fig. 1. Diagrams to show by annual increments the number of publications relating to North American geology and applied geology since 1886, and the percentage of total publications of the United States Geological Survey relating to applied geology during the same period.

its advance to that of the science of pure geology, as well as to the evolution of economic, political and social conditions. Though the keynote of the address is made the importance of the scientific investigator having always in view a result which in some way is to improve

> There is, however, grave danger that, carried away by the present furor for practical results, we may lose sight of our scientific ideals. Applied geology can only maintain its present high position of usefulness by continuing the researches which advance the knowledge of basic principles.

To his address Brooks has contributed the results of an inquiry to determine what percentage of American geological publications issued during the last quarter of a century has been devoted either wholly or in part

[1] Alfred H. Brooks, "Applied Geology," presidential address delivered before the Geological Society of Washington, December 13, 1911, *Jour. Washington Acad. Sci.*, Vol. 2, No. 2, January 19, 1912, pp. 14–48.

to applied geology. His results are graphically set forth in the upper diagram of the figure. While his method is not above criticism, it probably gives a crude idea of both volume and scope of American geological publications in recent years. It is based upon a count of publications listed in the annual survey bibliography of North American Geology, the papers in pure and applied geology being separated on the basis of their titles. By the same method, a separate count was made of the publications of the U. S. Geological Survey with results reproduced in the lower diagram of the figure. Upon this diagram the reviewer has indicated the periods of the Powell, Walcott and Smith administrations of the survey, since these appear to be not without significance. This diagram shows that although in 1890 less than 1 per cent. of the publications issued by the federal survey treated either wholly or in part of applied geology, no less than 98 per cent. of those issued in 1910 were in this field. Probably the real change is somewhat less striking than the figures indicate, since pure science is often included in reports primarily economic, but no one familiar with the recent transformation of the United States Geological Survey will doubt that the figures are essentially correct. A comparison of the upper and lower diagrams furnishes a sufficient refutation of the notion that the universities of the country have degenerated by the same proportion during the period covered by the investigation.

The apology for this state of affairs, which we think every true friend of science must deplore, is made by Mr. Brooks in the following terms:

> If geologic surveys are properly a function of the state, in the last analysis the people must be the final arbiters as to what phase of science is to be emphasized. In our democracy the citizen has the right to inquire what he, as a member of the body politic, is gaining by expenditures from the public purse.

These statements, of course, ignore completely the well-recognized fact that in the long run the greatest material gains have come through basic studies in pure science and not from "hand-to-mouth" investigations which have always a definite economic end in view; as they do also the further fact that the people are not expert geologists and expect to be advised by those who are and who are employed by them. Most geologists will admit that studies in applied geology were near the close of the Powell administration somewhat too largely subordinated to larger and more fundamental investigations, and that this had much to do with the temporary setback which the survey then received; but in this there is no justification for the almost complete neglect of work in pure science which has been characteristic of later administrations. No one doubts that an entire surrender to the politician clamoring for quick returns makes the securing of survey appropriations comparatively easy, but it should not be concluded from this that the present tendency in the survey is approved by the people of the United States.

Mr. Brooks ventures the opinion that "one reason why the investigators of this continent have accomplished so much for the advancement of geology is that their research has never been entirely divorced from the field of applied science." The reviewer would venture the opinion, and the facts seem to support it, that the great era of American geology was already passing as the craze for investigations in applied geology was gathering headway. Mr. Brooks's further statement that "advances in pure science were always in more or less direct proportion to advances made in the applied sciences," would be much improved by transposing "pure science" and "applied science." We doubt the truth of the statement that "science has made most rapid strides at those times when its study was inspired by desire to achieve some practical end." The declaration that geologic research "has for its aims the application of scientific principles to the needs of man" should be prefaced by the statement, "As interpreted by the United States Geological Survey." In many quarters, we believe, its aim is still quite as much the discovery of scientific principles as their adaptation to the needs of man. "We are now," says Mr. Brooks, "applying science to the affairs of the nation as never before. The old-fashioned publicist with his classical education, or, at least, traditions, is being shouldered out of the way by the man who analyzes the problems of public welfare on scientific principles. . . . Yet there are not a few geologists, though I believe a constantly decreasing number, who seem to view with suspicion any attempt to make the science of geology more useful." We believe comment upon these statements would be altogether superfluous.

Wm. H. Hobbs
University of Michigan,
June 4, 1912

PREPARATION OF WHOLE POLLEN MOTHER CELLS

To the Editor of Science: The brief article by Albert Mann on the preparation of whole pollen mother cells for the examination of mitotic figures, in Science for August 2, suggested that others might be interested in some experiments made along the same line by the writer during the winter of 1911–12. The technical difficulties presented by the method worked out at that time are somewhat greater than in that suggested by Mann, but the results were, on the whole, quite satisfactory.

Whole anthers, which from previous examination were known to represent the stages wanted, were fixed for 30 hours in strong chrome-acetic acid. They were then carefully washed in running water for 24 to 30 hours and gradually run up to 80 per cent. alcohol, in which they were allowed to harden for several weeks. They were then stained for 3 to 5 days in a strong cochineal tincture or in Kleinenberg's hematoxylin. The stains were rinsed off with 80 per cent. alcohol. The specimens were further dehydrated, and after resting in absolute alcohol for 6 to 8 hours were put into a mixture of equal parts of absolute alcohol and cedar oil in an open vial or small cylinder. They were allowed to remain in the open vessel on the paraffin oven until the alcohol had completely evaporated, requiring 2 to 3 days. Finally specimens were carefully dissected or teased apart in a drop of oil on a slide, and mounted by the addition of a drop of cedar-oil-balsam and a cover.

The important points are the hardening of cell walls before staining, the use of 70 per cent. alcoholic stains which do not overstain, and the gradual transfer from dehydrating to clearing and mounting medium, thus avoiding shrinkage of delicate cells. To any one acquainted with the two classes of stains the advantage of one which does not overstain to one which must be washed out for differentiation is well known, when dealing with mass staining. In trying out Mann's suggestions the writer found difficulty in preventing collapse of cells and in getting uniform results from the stains. The triple stain is especially difficult to manage in mass staining, and although a solution of Orange G. in clove oil, which gives the very best results with sections, was used, only a small portion of the material gave really satisfactory results.

Some of the stains used by the writer are new and the formulæ are given here for those who may care to try them.

Cochineal Tincture, Ammonia-acetate.—Digest 5 g. powdered cochineal with 150 c.c. 70 per cent. alcohol and 3 c.c. of glacial acetic acid at a temperature of 60–70° C. for 5 to 8 hours. Add ammonia until solution is neutral or but slightly acid and digest for 4 or 5 hours as before. Cool and filter until clear. Transfer to stain from 70 per cent. or 80 per cent. alcohol and rinse off excess with the same.

This solution does not overstain, and with material fixed in chrome-acetic acid stains chromatin lavender to violet and protoplasm a very light pink. In preparing fern prothallia for whole mounts the writer has found this to stain sperms and egg cells a violet tint with cell walls rose color.

For preliminary examination of pollen mother cells the old acetic-methyl green (5 per cent. to 10 per cent. glacial acetic acid added to a half saturated solution of methyl green in water) is the most generally useful, but it is of little value where gelatinous or slimy sap is present. For such cases the writer has found the following solution of chloral hydrate and methyl violet of great value.

Methyl Violet—Acetic-chloral Hydrate.—To an almost saturated solution of chloral hydrate in distilled water add 10 per cent. volume of glacial acetic acid and enough dry methyl violet to make the liquid a bright violet color. This stains nuclei very quickly, and does not stain slimes so as to hinder observation.

The balsam used in mounting is oven-dried and then dissolved in pure cedar oil.

F. L. Pickett

Botanical Laboratory,
Indiana University,
August 10, 1912

PERSONAL REGISTRATION OF FAMILY MEMORANDA: A PLEA FOR THE MAKING AND PRESERVING OF HOMELY ANNALS

Human efficiency is recognized to be the most desirable asset. Every one admits the expediency of attaining and perfecting individual capabilities.

Latent capabilities, inherent energies, are of use only when rendered available. To render them available and serviceable, are demanded full opportunities plus expert help in development and elaboration.

Conservation of inherent potentialities in all lines of natural resources has become an avowed principle in American industrial energizing. The first step in systematic procedures is to collect significant facts. Till data become numerous enough, sufficiently uniform and precise, no safe inferences and reliable conclusions can be formed. To achieve ultimate truth is only possible through intelligent, persistent and world-wide cooperation. Such methods for laying the foundations of practical certitude are being applied to most lines of endeavor and economic progress.

The one conspicuous exception is the study of human efficiency. Here methods are so lacking in system, so disproportionate, as to disappoint reasonable expectations.

Bureaus of animal industry are proceeding with excellent system and thoroughness. Their methods already serve as models; their findings form the basis for important economies.

Especially defective are the means employed for preserving significant facts bearing on the life history, physical, psychologic, domestic and other factors of personal advancement in human beings.

This conclusion was reached while initiating a research the data for which were found unattainable. Conference with leading workers in economics, psychology, anthropology, clinical medicine and other promising sources of information confirmed a growing disappointment.

Here, then, we are halted at the threshold in a quest for fundamental facts essential to enlightenment. Deplorable neglect is discovered in the one department of research from which results of the gravest importance should evolve.

Wholly inadequate are the registrations of birth, marriage, death, and especially of the accompanying circumstances. Even such bare outlines of human history as are attempted by municipalities are admittedly partial, inexact, far from complete. The churches make some effort to preserve a few facts with little difference in result.

Carelessness in this particular is nearly as pronounced among the well-to-do and presumably intelligent as among the very poor and shiftless. Upon inquiry among the more liberally endowed, it will be found that few persons take the trouble to make and preserve any sort of systematic registration of incidents and circumstances of personal history. Experts in genealogy are put to all sorts of shifts to secure information.

Archaic as it seems, the family bible is still compelled to serve more or less inexpediently for the purpose; also legal instruments, such as wills, deeds, property transfers, personal and other epistles, and the like disconnected and accidental avenues of evidence.

The whole forms a pitiable, heterogeneous, but the only available source of information in what may prove to be a vitally important direction.

Data are especially meager on three groups of subjects:

1. Antecedent personal history making for knowledge of ancestry, and inheritance, including salient characteristics of individuals and the family.

2. Earliest phenomena of growth and development, including traits, tendencies, tastes, etc., constituting "infant records," which should be carefully registered at the time of observation.

3. Personal history of each member of the family from birth to present age and from all reputable sources; not only of the phenomena of infantile and later development and changes, but also accurate data on physical and other disorders, illnesses, accidents, repairs, corrections, etc.

Only by the aid of light thus shed is it possible to form present or future determinations.

In a complete registration many other points should be covered, such as: full and accurate accounts of illnesses, injuries, peculiar physical and mental occurrences, when they occur; and, equally important, the nature and character of repairs or corrections, when made. All these are of vast utility to the individual.

The foregoing category of findings, if made of a large number of individuals and on a uniform system, would, it is obvious, constitute invaluable data for use by the scientific research worker, especially the physiologist, the psychologist, eugenist, human-economist and sundry others.

There is yet another grouping of facts deserving of encouragement: no less than what may be included in the term, "special happenings." This may embrace the whole realm of momentous incidents, memorabilia, liberally interpreted. Among these may be mentioned lines of education pursued, special types and kinds of training, evidences of predilections, aptitudes as they appear, develop or change; decisions made, purposes carried out well or ill, volitions, vocations, scholastic records, etc.

Finally it may be said, there are few or none but would welcome and make use, less or more, of such records, did they exist ready made.

Whatever is thus worthy is worth the effort to construct. It would contribute much to pleasure, satisfaction, sustained and increasing interest and self-respect.

The practical utility of such *annals* to each one is clear. As a contribution to scientific data a few thousands such would prove priceless.

I would suggest that the head of each and every family, however small, keep an accurate, succinct record of essential facts and opinions. In order that these should be uniform the book should contain carefully prepared blanks, questionnaires, memoranda of salient points, etc., which should in each instance be covered to make the records complete.

Such a family history register I have carefully outlined, with kind help from eminent specialists in biology, psychology, eugenics, economics, euthenics, clinical medicine and genealogy. No family record book has as yet been published which altogether meets popular requirements. The "life history album" of Sir Francis Galton is unsurpassed for purely scientific findings, but not adapted to popular use. There are many excellent "baby books" of limited scope, chiefly sentimental.

To serve domestic and economic as well as scientific purposes, blanks and questionnaires should cover (concisely) pretty much all points in human interests, otherwise it will be difficult to induce heads of families to realize the *practical advantages* accruing, which are of the utmost value, and to take interest in making the notes.

Wide cooperation is essential; scattered data are valueless; many thousands of facts are required.

In an ideal register several features must be included appealing to sentiment, obvious utility and commendable self-complacency. For popular acceptance certain points are desirable, comprising, among others:

Blanks for *index* (including marriages, births, deaths, dates, places, etc., with page references to additional inscriptions in the book).

Chart for genealogy (*e. g.,* to about the eighth generation—direct ascendants' names to correspond to a number and kept on special blanks; collaterals to be registered on separate blanks).

Blanks for *baby records* (growth, development, etc., complete in physical and psychologic features, but not too exacting—extra data to be inscribed on special pages provided).

Blanks for *personal history* (of each individual of over one year of age, from birth to time of writing—later occurrences to be placed under "special happenings").

Blanks for *phenomena of attack of illness, injury or operation* (when they occur—to be filled in by physicians).

Charts for *weight and height* (also tables of standard weights and heights). Blanks for *observations and findings of specialists;* charts for *special clinical data* (eye, ear, nose, throat, etc.); blanks for *laboratory findings* (urine, feces, blood, sputum, etc.); pictorial charts for *anatomical memoranda;* blanks and charts for *dental memoranda;* special blank for *photographs* (interesting to preserve photographs at different ages, of children and adults); and, among the most important, pages for *special happenings,* notable occurrences of personal history, including memorabilia of tendencies, trends of thought, genesis and course of purpose, cherished or revealed potentialities, ideals, conduct, self-discipline, lines of development, of capacities, education, achievements, distinctions, renunciations, conservations, etc., constituting a picture of the evolution of personality.

The whole to afford accurate data, whereon alone can be based many present and future determinations, mental and voluntary processes, decisions and economies in health, mental and physical, legal and insurance precisions, inheritance, etc.

The author will be grateful for any comments, criticism and especially for encouragement.

J. Madison Taylor

Philadelphia, Pa.

HERMAPHRODITE FEMALES IN LYCHNIS DIOICA

Some years ago Strasburger[1] reported that female specimens of *Melandrium rubrum* Garcke (a form of *Lychnis dioica* L.) growing in his experimental garden at Bonn, were changed to apparent hermaphrodites as a result of infection with the anther-smut, *Ustilago violacea.* The infected plants had fully developed stamens, but the sporogenous tissue of the anthers was completely replaced by the spores of the smut. Strasburger suggested that all the cases of hermaphroditism which had been occasionally reported in this species were probably due to infection by *Ustilago.*

When I discovered functional hermaphrodite mutants in *Lychnis dioica* and demonstrated by numerous genetic experiments[2] that these functional hermaphrodites are modified males, I believed that Strasburger had misinterpreted his material and that his hermaphrodites which resulted from infection by *Ustilago* were produced by the development of female organs in the male, and not as he supposed by the development of male organs in the female. Strasburger was correct, however, as to the nature of his apparent hermaphrodites, as demonstrated by two facts which he has recently pointed out,[3] namely, (*a*) that the females are not always completely infected, in which case the uninfected branches bear normal female flowers, and (*b*) that infected males show no development of the female organs.

Professor Doncaster, of the University of Cambridge, England, has tested the influence of *Ustilago violacea* upon *Lychnis dioica* by artificial infections, and his results completely corroborate the conclusions of Strasburger. He sends for publication in Science the following brief account of his experiments:

It is well known that *Lychnis vespertina* is diœcious, but that all plants infected with the fungus *Ustilago* have well-developed stamens. Some of these plants have the typical male form, without trace of ovary; others have a vestigial ovary and styles in addition to the stamens and anthers filled with *Ustilago* spores. This suggests that when a female plant is affected by the para-

[1] *Biologisches Centralblatt,* XX., 657 et seq., 1900.

[2] *Botanical Gazette,* XLIX., 110, 1910.

[3] *Jahrbuch für wissenschaftlichen Botanik,* XLVIII., 427, 1910.

site, the stamens are caused to develop and the ovary is reduced, while the form of the flower of a male which is infected is not altered. In order to test this suggestion, I planted some ustilaginized plants in my garden in the late summer of 1910, and put with them some uninfected plants which I attempted to infect by sprinkling them with spores and by rubbing spores into parts of the stem from which I had scraped away the epidermis. The results were as follows: Of seven females which I attempted to inoculate in August, 1910, one became infected, and had the typical "hermaphrodite" form of flower in October, but in June, 1911, was again quite free from *Ustilago*, and had typical female flowers. A second female plant showed infection in June, 1911, but only on part of the plant; one branch was quite clean and had typical female flowers, the rest of the plant was infected and had "hermaphrodite" flowers.

Of eight male plants which were inoculated in August, three showed some infected flowers before the end of September; the anthers contained *Ustilago* spores, but there was no change from the male type of flower. Three of these eight plants were dead in June, 1911; one of the remaining five was infected.

Of five ustilaginized plants transferred to the garden, four had the hermaphrodite type of flower and one the male. One of the hermaphrodites so far recovered in September, 1910, as to set some seed; in 1911 all were still infected. One of them had some branches with hermaphrodite flowers containing large ovary, short styles and stamens with little or no pollen, but without *Ustilago* spores, while the rest of the plant had flowers with anthers full of spores, and the ovary and styles more reduced.

These observations seem to prove that infection with *Ustilago* can turn the female flower into the apparent hermaphrodite, but that no production of female organs takes place in a male flower when it becomes infected.

L. Doncaster

Cambridge, England

The occurrence of uninfected hermaphrodite flowers on one of Doncaster's original infected plants may possibly indicate that this plant was not a female previous to its infection, but a hermaphrodite. If it were possible to secure pollen from a ustilaginized female, certain genetic problems of very great interest might be solved. It is of great theoretic importance to know whether infection by *Ustilago* affects the genotypic nature of the host. If the effect is purely somatic, as seems to me the more probable, the offspring of a self-fertilized hermaphroditic female, or of a normal female fertilized by sperms from a hermaphroditic female, should consist only of females (if uninfected), and not of females and hermaphrodites, as I have shown to be the case when a female is fertilized by a hermaphroditic male. If infection by *Ustilago* produces a genotypic modification, it would be interesting to know whether such induced hermaphrodites are homozygous like the females by whose modification they are produced; they should in that case yield only hermaphrodite offspring. Hermaphroditic males produce both female and hermaphroditic male offspring, because the males are sex-heterozygotes.

As I have been fortunate enough thus far not to have a single infection from *Ustilago* among the many thousands of individuals of *Lychnis dioica* which have been involved in my cultures during the past seven years, I do not care to take up at present the here suggested line of investigation upon ustilaginized females. I do not wish to jeopardize by importing infected material, the solution of many other genetic problems now under investigation, but I hope that Professor Doncaster or some one else who is in a position to do so, will give attention to breeding from hermaphroditic females if this proves to be technically possible.

Geo. H. Shull

SCIENTIFIC JOURNALS AND ARTICLES

Contents of the September number of *Terrestrial Magnetism and Atmospheric Electricity* are as follows: "A New Type of Compass Declinometer," R. L. Faris; "The Physical Theory of the Earth's Magnetic and Electric Phenomena, No. VI.: On the Origin of the Earth's Magnetic Field," L. A. Bauer; "Magnetic Declinations and Chart Corrections Obtained by the *Carnegie* from Batavia to Manila, and Thence to Suva, Fiji, November, 1911, to June 5, 1912," L. A. Bauer and W. J. Peters; "Resultate der Inklinationsbeobachtungen der Deutschen Südpolar Expedition 1901 bis 1903," Fr. Bidlingmaier; "Regarding Magnetic Records Obtained in Cooperation with Captain Scott's Antarctic Expedition," C. Chree; "Magnetic Character of Days as Observed at the Cheltenham Magnetic Observatory, April 1 to June 30, 1912," G. M. T., O. H. Tittmann; "The Magnetic Character of the Year 1911," G. van Dijk; "Levé Magnétique der Bassin du Rio S. Francisco," H. Morize; "Observation of the Magnetic Declination at Warsaw during the Solar Eclipse of April 17, 1912," S. Kalinowski; "On the Movement of Inertia of Long Magnet H 26 at the Cheltenham Magnetic Observatory." R. L. Faris; Abstracts and Reviews.

SCIENTIFIC BOOKS

The Influence of a Magnetic Field upon the Spark Spectra of Iron and Titanium. By Arthur S. King. Publication No. 153. Carnegie Institution of Washington.

It is assumed that the readers are familiar with line spectra produced by luminous rays from dissociated particles of the metals. Most readers will also be familiar with the following fact, viz., when these lines are produced in a magnetic field they break up into three or more components. This is called the Zeeman effect.

By reason of Hale's epoch-making discovery of a Zeeman effect in solar lines, this phenomenon has come to have a large interest to astrophysicists as well as to physicists. This iron and titanium study should particularly appeal to the former.

The Zeeman effect is much more complicated than the simple theory first indicated. The separations differ in magnitude, number of components, relative spacing of the components, relative intensity and relative sharpness. Farther, the intensity of some of the components is relatively increased (enhanced) with respect to the original line, others are relatively decreased. All of these items are important in the determination of spectral series and in arriving at the physical condition of the luminous particles. Each spectral series generally shows but one type of separation. Furthermore, some of these types repeat from substance to substance, showing an intimate electronic relationship in the molecule of different substances. The phenomenon grows very complex in the detailed study of the different elements. The "Zeeman effect" and spectral series stand almost alone in showing us what a wonderful complex structure exists within every atom. Not all the complexities of the phenomena have been explained. Still, theory has kept well apace with the observations and has often pointed out the way. So important in the latter respect has been some of the contributions by Ritz, that I should like to add at least one of his contributions[1] to the very complete bibliography given by Mr. King.

While all the above characteristics are important no observer has recorded them all, not caring to encumber his data with detail which is not immediately fruitful. Likewise there is much curtailing of the computations. In a paper published by the Carnegie Institution, it seems to me that items of possible future as well as present value might be recorded and save a great amount of labor.

The components of many lines lie so very close together that it is necessary to separate the two kinds of vibrations by some polarizing device, and photograph each separately. The very important relation of the intensity of these kinds of vibration can not then be found accurately since it is impossible to maintain light at the same intensity for the two exposures. But it occurs to me that, with the non-astigmatic Littrow spectroscope which Mr. King has used, one could focus the double image of an interposed calcite upon the slit and photograph both kinds of vibrations coincidently in juxtaposition.

Particularly among the several component lines, there seems to be a certain degree of order. They are often stepped off in uniform spaces. These steps differ in magnitude from line to line, but all seem to be simple fractional parts of a standard value, called the normal, *a*. Furthermore, this "normal" has the value we should expect from the ratio of

[1] *Ann. d. Physik*, 25, 660, 1908.

electrical charge to the mass of the simple electron. This has been interpreted to mean that the rotating (vibrating) electron does not produce an appreciable magnetic field but that the complexity arises from "linkage" of the electrons in different ways. I will illustrate this simplicity of step arrangement by citing from Mr. King's work three iron lines, viz., 3722.7 λ, 3872.6 λ and 5447.1 λ. The spacings are all "normal" and the steps are (1, 2, 3, 4) for one kind of vibration and 1, 2, for the other kind of vibration so that King writes the line $\pm$ (1, 1, 2, 2, 3, 4) a. From his tabulated measurements I have computed the value a, and find it for the three lines to be respectively $.730 \pm .008$, $.752 \pm .006$ and $.758 \pm .006$, whereas his field strength would give .753. One notices but a slight deviation in the first, which arose from a probable error in one measurement. These little details in computation may add much to the conclusiveness of a statement. Neither such simplicity nor so conclusive a relationship is present in the twelve component thorium line 4086.7 λ.[2]

For most substances the majority of lines are triplets, which corresponds to the simplest form of the theory developed by and predicted by Lorentz. However, these triplets show great variety in magnitude and appearance.[3] Mr. King thinks there is some tendency for these lines to group about magnitudes related to the "normal." For example, he finds that thirty-five sharp lines (Table IV.) can be grouped under the magnitude $3a(=2.26)$. I find twenty of these lines to lie between 2.21 and 2.32 with an average of 2.275. This is a difference of five per cent. in the extremes. For a considerable distance upon either side of this space (2.21 to 2.32) there are but few lines of corresponding sharpness. This fact seems favorable to a single group in this list. But the real necessity here is the same as I pointed out in case of thorium, viz., a little greater accuracy (or greater resolving power of the spectroscope). For example, reduce this extreme error in variation from five to one per cent., possibly even two per cent., then we shall know whether there are steps in the magnitude of the triplet separations or whether there are a great variety of separations differing by small increments of value. The latter result implies that the electrons are vibrating in a self induced, as well as the superimposed magnetic field.

I fail to see the validity of Mr. King's law (p. 54): "*Since* $D\lambda/\lambda^2$ (*i. e.*, change in frequency of vibration per sec.) *is shown to be nearly a constant, . . . the mean separation of the n-Components* (*i. e.*, components which vibrate perpendicular to the lines of force) *varies as the square of the wave length.*" The notes in parentheses are added by way of explanation. One thing made certain by experiment and theory is that different types of separation correspond to different physical aggregates, unions, or "linkages" of electrons; and Preston's law shows that any *single type* may repeat itself in lines throughout the spectrum, according to this *very* law that King enunciates. That the mean of all types should give a uniform value throughout the spectrum, implies only that all types are fairly well distributed throughout the spectrum. Such a statement has no particular value. For in a chance distribution, by the law of probabilities, such uniformity must increase as the number of lines increase. Mr. King's Table VII. shows this.

The most important place in Mr. King's paper is given to a discussion of the relation of the magnetic separation to a displacement in the position of the spectral lines which arises when the radiating particles are subjected to an external pressure. The latter is a well-known phenomenon. However, no explanation of it has found extended acceptance. Humphrey's theory involves a strong magnetic field induced by the rotating electrons. As observed above, such a field is by no means certain. But this theory and the prominence of both phenomena in solar lines form the principal reasons for an examination of their possible relationship. Tables XI. and XII. show the ratio of the two quantities for different lines to vary twenty-five fold. Then at

[2] *Astrophysical Journal*, XXX., p. 151, 1909.

[3] See King's references to Purvis, Moore, Jack, Cotton and Babcock.

once one would infer there is no relationship between the phenomena. However, Mr. King analyzes the lines by subdividing them into groups, and concludes "that a close correspondence does not exist, but there is a general agreement as to magnitude of the two effects when the means of a large number of lines are considered." I should like to add, that the "means of a large number of lines," leaves much to be desired in the proof of a relationship. Mr. King's method of subdivision carries with it another suggestion. When he divides the separations into small, medium and large, he reduces the number of types of separation in each class. For clearly a line whose separation is small does not belong to the same type as one whose separation is large. Again he selects the ratio of each of three subdivisions to low, medium and high displacement respectively. This gives arbitrarily nine divisions. By this method he shows there is an approach toward uniformity in relative magnitude. The suggestion is, what may we expect when these groups are broken up into real series types? Comparing the three iron lines mentioned above gives nothing of promise, although close measurement may show two of them to agree. But in the absence of an established series one can not affirm that these lines belong together. If this point has any merit, it would be worth while to compare substances among whose lines definite series have been established.

The tabulated data for the author's two substances lack just one thing, viz., the ultraviolet spectrum, to make them the most complete study which has appeared.

B. E. Moore

University of Nebraska,
August, 1912

Introduction to General Thermodynamics. By Professor Henry A. Perkins, Trinity College, Hartford. Wiley and Sons.

Recognizing the lack of suitable text-books in English on thermodynamics for students of physical chemistry, the author in writing this book has attempted to make good the deficiency.

The volume comprises some 225 pages of octavo size subdivided into eight chapters, the titles of which in order are: General Heat Relations; The First and Second Laws of Thermodynamics; Entropy; Thermodynamic Equations; Perfect Gases; Real Gases; Change of State; The Solution of Problems. At the end of the book there are eight tables giving gas constants, thermoelectric and calorimetric constants of certain substances, density and thermo-elastic coefficients of certain liquids and solids, critical and Van der Waals constants, coefficients of expansion of gases and relation of pressure units in various systems.

The methods of presentation and demonstration employed by the author are for the most part classical and it is therefore unnecessary to refer to them specifically. The emphasis laid upon the doctrine of available energy as a means of interpretation of the second law is notable. The various thermodynamic potentials and the phase rule of Gibbs receive appropriate attention. The last chapter is noteworthy on account of the large number of problems which are proposed for solution by the student. Solutions of typical problems are given.

The scope of the book appears to be quite adequate for the purposes which the author has in view. A remarkable amount of material is condensed into a small volume through the aid of mathematical expressions; and although the demands made upon the mathematical knowledge of the reader are not very great it would appear that the author probably intends the book to be used by students having the advantage of a competent instructor. Professor Perkins has, in writing this book, furnished a valuable addition to the English text-book literature of thermodynamics.

A. P. Wills

Astronomy in a Nutshell. By Garrett P. Serviss. Illustrated. G. P. Putnam's Sons. 1912. Pp. xi + 261.

There are so many excellent popular books on astronomy and its different branches, that a new work is unnecessary unless the author has new material to present or can place before the reader the old facts in a novel and interesting form. Judged on these lines, this book of Mr. Serviss is wholly unnecessary: it presents old material in a stereotyped, uninteresting and unattractive form. The explanations of many of the motions of the solar system are obscure, and fail to give the reader an adequate understanding of the underlying principles involved.

The book contains many illustrations, but the pictures in most cases bear no relation to the accompanying text. Photographs of the surface of the moon are scattered through the chapter devoted to definitions and explanations of such astronomical terms as horizon, zenith, altitude and azimuth; while amid the pages devoted to a description of the moon appear photographs of various nebulæ.

CHARLES LANE POOR

A Beginner's Star-book. By KELVIN MCKREADY. G. P. Putnam's Sons. 1912. Illustrated. Pp. vii + 148.

This little book is a beautifully printed and illustrated guide to the stars and star groups. The star charts and key maps, intended as guides for the amateur observer, are arranged on a somewhat novel plan. For each season of the year two charts are printed, one showing the sky as the observer faces the south, the other the sky as the observer faces the north. This undoubtedly facilitates the finding of those stars situated either directly north or south and not too high above the horizon. But the charts are rather confusing when the star one seeks to locate is nearly overhead, or far to the east or west.

The illustrations, showing the principal nebulæ and star groups of the heavens, are from photographs taken at the Yerkes Observatory, and are wonderful reproductions and triumphs of the printer's art. As a whole, the book is admirably adapted for its purpose, and should interest many in the study of the heavens.

CHARLES LANE POOR

SPECIAL ARTICLES

UROPHLYCTIS ALFALFÆ, A FUNGUS DISEASE OF ALFALFA OCCURRING IN OREGON

EARLY in the year 1910 the writer noted the occurrence of a crown gall disease of alfalfa in the Rogue River Valley near Medford, Oregon, but, on account of other pressing work, the character of the disease was not investigated until later. However, during 1911, owing to the fact that the disease began to show rather seriously in many of the large alfalfa fields, an investigation was begun and considerable field and laboratory work was done. An examination of a large number of fields with plants from two to seven years of age showed large areas where the plants had died, or where the growth had become very weak. On examining the plants within these areas, it was found that the crown and part of the stems just above the crowns were badly infected with numerous galls, varying from an eighth of an inch or less to sometimes four inches in diameter. These galls are much warted externally, and more often a large-appearing gall is made up of a number of smaller galls which have become united. Very rarely were there any galls found on the root system, and none at more than six inches below the surface of the ground as the plants stood in the field. The disease seems to affect the shoots or stems as well as the crowns and roots, and many specimens were found where the galls covered the stems fully five or six inches above the crowns. In the field, diseased plants usually show a very roughened crown from which only weak, chlorotic stems arise, the leaflets also being very small and lacking the normal green color. In the few references which the writer has had the opportunity to see, and which are cited below, it has been stated that the fungus was observed to be most destructive to plants on damp ground. My investigations have shown that this is not true. It has been found that even in the best drained sandy loam and gravel soils of this district (Rogue River Valley) the disease is quite as serious as in the heavy, poorly drained, "sticky" soils. It has been determined that most of the serious injury attributed to disease in the heavy soils is, after all, due to lack of drainage. An examination of the root system of plants not diseased shows that the root system penetrates only a short distance, and the root terminals, instead of being tapered, have a rounded or blunt appearance.

CAUSE OF THE DISEASE

A microscopic examination of the galls shows the disease to be due to *Urophlyctis alfalfæ* (v. Lagerh.) P. Magnus. The galls are merely hypertrophied tissue of the host plant, and contain minute cavities which are filled with masses of the brown resting spores which measure approximately 40 micromillimeters in diameter. The fungus belongs to the Class Chlorophyceæ, Order Protococcales, Family Chytridiaceæ, Subfamily Olpidiæ. The sexual resting spores are formed by the union of two sporangia and the passing of the contents of one into the other. The mycelium which produces several fruiting bodies en masse is more or less developed. The fruiting bodies are almost spherical and brownish in color.

This disease was first recorded in 1892 by Lagerheim, who found it in Ecuador. He, however, placed the parasitic fungus in the genus *Cladochytrium.* Magnus, in 1902, found it in Alsace, Germany, and referred the fungus to the genus *Urophlyctis.* Until 1909, the disease had not been reported in the United States, although it had been found in South America, Germany, England and other foreign countries. In 1909, it was reported from both California and Arizona. A year later the writer found it in southern Oregon, but nothing was published until 1911, when a preliminary statement was made which appeared in the local press.

During the past season the writer has been doing considerable work on the histological effect of the fungus, as well as the determination of the manner of natural infection, etc. A detailed paper will be published later.

The literature on this disease is not very extensive; the references which the writer has at hand are as follows:

von Lagerheim, G., "Mykologische Studien. I., Beiträge zur Kenntniss der parasitischen Pilze," 1–3. *Bihang till K. Svenska Vet.-Akad. Handlingar.*, Bd. 24, 1898, Afd. III., No. 4. Abstract in *Centbl. Bakt.* (etc.), II., 5, 558–560.

Magnus, P., "Ueber die in den knolligen Wurzelauswuchsen der Luzerne lebende *Urophlyctis.*" *Ber. deut. bot. Gesell.*, 20, 291–296. 1902.

Salmon, E. S., "*Urophlyctis alfalfæ*, a Fungous Disease of Lucerne in England." *Gard. Chron.*, III., 39, 122. February 24, 1906.

Smith, Elizabeth H., "A Note on *Urophlyctis alfalfæ* (v. Lagerh.) P. Magnus, in California." SCIENCE, N. S., Vol. XXX., No. 763. August 13, 1909.

Smith, Elizabeth H., "A Note on *Urophlyctis alfalfæ* in California." Experiment Station Record, Vol. 21, No. 6, November, 1909.

McCallum, W. B. (Plant Physiology and Pathology). Arizona Station Report, June 30, 1909.

McCallum, W. B. (Work in Plant Pathology). Experiment Station Record, Vol. 23, No. 7, December, 1910.

O'Gara, P. J., "*Urophlyctis alfalfæ*, a Crown Gall Disease of Alfalfa New to Oregon." Medford *Mail-Tribune*, August 29, 1911.

P. J. O'Gara
Office of the Pathologist,
Medford, Oregon

A COMPARISON OF THE "MAMMOTH" AND SPANISH PEANUTS AS GROWN IN CENTRAL IOWA

In the spring of 1911, the writer procured seeds of two varieties of peanuts, a strain of the Virginia peanut known as the "Mammoth" and advertised as combining earliness and large size and as being very prolific, and the small Spanish peanut. The "Mammoth" peanut seed was obtained from the Mills Seed Co., Washington, Iowa, and the Spanish peanut from Burpee, of Philadelphia. Both kinds were planted the same day, May 8, and in neighboring rows in a rich soil, which was not, however, a good peanut soil, as it was rather heavy and liable to cement and run together. Both kinds received the same treatment and were gathered the same date, October 23, the date of the first killing frost, unusually late for this section.

The Mammoth peanut hills were only a few in number. They made much higher, larger stalks and were inclined to spread over the ground more. They bore the peanuts rather loosely scattered, so that although they were not exactly the running type of plant one had to go over considerable ground to get the crop. They continued blooming profusely until frost and although the majority of peanuts were ripe they were found in all stages from the blossom to the fully ripened nuts. Of the few plants raised and examined the most prolific bore 26 nuts, the least fruitful 19, with an average of 21 per vine.

The Spanish peanuts bore their nuts in dense clusters all set close to the main stem, so they were much more easily gathered. Though they still continued to blossom at frost, the great majority of the nuts had ripened very solid and firm and a few had actually germinated so that young plants were breaking the soil when gathered. The most prolific plant bore 82 nuts, the least fruitful is somewhat doubtful as the plants had broken up somewhat. A stalk, very likely a broken branch, bore only 10 nuts, but the least prolific entire plant bore 23 nuts, the average number of nuts per plant being 53 per vine, or considerably over twice the yield of the Mammoth.

The nuts of the Mammoth peanuts were not so immense as some of the Burpee New Mammoth Bush Peanut seen several years ago, and the hulls were not so thick; however, they were somewhat larger than the common Virginia peanut of the markets. The following figures give the result of weighing and measuring a lot taken at random:

WEIGHTS, MEASUREMENTS, ETC., OF "MAMMOTH" PEANUTS

Measurement of Nuts			Measurement of Kernels		
Serial No.	Length, Mm.	Diam., Mm.	Serial No.	Length, Mm.	Diam., Mm.
1	44	17	1	23	12
2	46.5	16	2	20	10
3	48	14.5	3	21	10
4	49.5	17.5	4	20	9
5	46	17	5	21.5	9
6	42	15	6	22	9
7	45	19	7	18	9
8	50.5	16.5	8	20.5	8
9	42	16	9	21	9.5
10	45	14.5	10	23	9
Av.	45.85	16.3	Av.	21.0	9.45

It took 20 peanuts of this variety to weigh 50 grams; of these 5 peanuts were wholly bad, and the 20 nuts yielded 33 kernels, of which 8 were shrivelled, leaving 25 good kernels; the 33 kernels weighed 30.7 grams, or 61.4 per cent. of the entire weight of the nuts.

WEIGHTS, MEASUREMENTS, ETC., OF SPANISH PEANUTS

Measurement of Nuts			Measurement of Kernels		
Serial No.	Length, Mm.	Diam., Mm.	Serial No.	Length, Mm.	Diam., Mm.
1	24	10	1	13.5	9.5
2	24	11	2	12	8
3	24	11	3	11	8.5
4	24	12	4	11	8.5
5	25	11	5	12	9
6	26	10.5	6	10	8
7	25	10.5	7	11	8
8	25.5	11	8	12	7.5
9	28	11	9	13	8
10	24.5	12	10	10	8
Av.	25.0	11.00	Av.	11.55	8.3

It required 47 of these peanuts to weigh 50 grams. All the peanuts were good, and produced 91 kernels, of which only 1 was shrivelled. The weight of these kernels was 38.5 grams, or 77 per cent. of the entire weight of nuts.

Comparing plant by plant of the 2 varieties, the average plant of the Mammoth peanut yielded 21 peanuts, weighing just a trifle over 50 grams. Of these, about 5 would be unripe or otherwise bad, and one would get 30 kernels weighing about 30 grams. Of the Spanish variety the average plant yielded 53 nuts weighing about 56.4 grams, the whole amounting to 102 kernels, weighing in the aggregate 43.1 grams.

Comparing the net output then in kernels, the Mammoth peanut yields 30 grams to 43.1 grams yielded by the Spanish peanut, or a little over 68 per cent. as much.

At the outset, it appears that the Spanish peanut, which is so much more easily gathered and yields so much more heavily, would be the most desirable form to cultivate. On account of the more compact habit it could indeed be planted somewhat closer and the yield correspondingly increased.

A comparison of the nuts yielded by the two varieties shows points of favor for each one. The Mammoth nuts are much larger and handsomer and would be more attractive on the market. This is offset by the fact that the shells are much thicker and the kernels do not wholly fill the cavities but rattle around loosely, while the Spanish peanut has a paper-thin shell, closely surrounding the kernel, so that there is no waste space. The kernel of the Spanish peanut is short, almost like a pea, and remarkably solid.

An unexpected difference, much to the advantage of the larger peanut, lies in the labor involved in shelling the nuts. The thin, close-fitting shell of the Spanish peanut makes it exceedingly hard to shell the kernels rapidly, while this process is easy in the larger nuts. The extra work required when the Spanish nuts are to be shelled by hand more than offsets the ease in harvesting them.

Which variety would be most desirable to grow depends upon conditions. Where the season was rather short the Spanish would be better, and where the peanuts were raised for pig-pasture it would be much superior, as the only disadvantage of the Spanish nut, that of the labor of shelling the kernels, would here not be considered.

The purpose of taking the diameter of the nuts and kernels was to show the difference in waste as regards cross-section. The shells differed markedly in thickness, and this could not be satisfactorily compared, as the irregularities made such measurements of little value in themselves; moreover, there was an empty space between the kernel and shell of the Mammoth variety to be taken into consideration. The measurements of whole nuts and kernels show that the diameter of the kernel of the Mammoth peanut was about 58 per cent. that of the entire nut, while in the Spanish peanut it was a little over 75 per cent.

H. Walton Clark

Bureau of Fisheries Biological Station,
Fairport, Iowa

CONTACT ACTION OF GABBRO ON GRANITE IN WARREN COUNTY, NEW YORK.[1]

While engaged in detailed field-work on the North Creek (Warren county) New York quadrangle, the writer found a fine example of contact action of gabbro on granite, which it is the purpose of this paper to describe.

The rocks of the region are all pre-Cambrian and these, named in relative order of ages, comprise the Grenville sedimentary series of various gneisses, limestone, and quartzite; the great syenite-granite intrusive masses; gabbro stocks or dikes; pegmatite dikes; and diabase dikes. The Grenville and syenite-granite series are highly metamorphosed and clearly gneissoid; the gabbro is only moderately metamorphosed; while the pegmatite and diabase are wholly unaltered.

The gabbro, which is of special interest here, almost invariably occurs in the form of small stocks or bosses (rarely as dikes) which break through the country rock (Grenville, syenite, or granite) in vertical, plug-like or pipe-like forms which on the geologic map show elliptical or nearly circular ground-plans. The gabbros are generally medium to coarse-grained, always holocrystalline, and they show every evidence of having been intruded under true plutonic conditions.

The contact metamorphism here described may be seen at the southern end of the gabbro stock (length ¾ of a mile) which lies just south of Mountain Spring lake or at a point 2 miles southwest of Pottersville. In a recently opened stone quarry, about 75 feet higher than the road on its east side, the rocks are laid bare in such a manner as to afford an excellent opportunity for the study of the contact zones.

The following nine zones, passing from the typical gabbro to the typical granite (country rock), have been studied in detail in the field and by means of thin-sections and hand-specimens:

[1] Published by permission of Dr. J. M. Clarke, New York State Geologist.

Zone 1.—Typical gabbro well within the gabbro stock. Nearly black, medium grained, and with diabasic texture. (Gradation from 1 to 2.)

Zone 2.—Syenitic phase of the gabbro stock and within a few feet of the granite. Dark gray, medium grained, and with granitoid texture. (Gradation from 2 to 3.)

Zone 3.—1 to 3 feet wide. Biotite-schist border phase of the gabbro stock. Secondary origin. (Sharp contact between 3 and 4 gabbro and granite.)

Zone 4.—4 inches wide. Hornblendite phase of the country rock (granite). Nearly black, medium grained, banded parallel to the gabbro-granite contact. (Fairly sharp contact between 4 and 5.)

Zone 5.—6 inches wide. Monzonitic phase of the country rock. Yellowish gray, medium to coarse grained, and banded parallel to the main contact. (Not very sharp contact between 5 and 6.)

Zone 6.—15 to 18 inches wide. Chiefly hornblendite phase of the granite, but with numerous very narrow streaks of No. 5. Nearly black, medium grained, and banded parallel to the main contact. (Sharp contact between 6 and 7.)

Zone 7.—3½ feet wide. Monzonitic phase of the country rock like No. 5. Yellowish gray, fairly coarse grained, and banded parallel to the main contact. (Not very sharp contact between 7 and 8.)

Zone 8.—7 feet wide. Monzonitic phase of the country rock. Light gray, fairly coarse grained, and not banded. (Gradation from 8 to 9.)

Zone 9.—Typical (country rock) granite. Pink, medium grained, and very gneissoid, but with gneissic bands striking at almost right angles to the main contact.

MINERALOGICAL COMPOSITION OF EACH CONTACT ZONE

Zone No.	Orthoclase	Microporthite	Microcline	Plagioclase	Hornblende	Hypersthene	Quartz	Biotite	Magnetite	Zircon	Zoisite	Pyrite	Garnet
1	5			Ol.-Lab. 45	14	20		6	2			1	2
2	32			Ol.-Lab. 10	45			6	2	little		little	5
3	Biotite-schist with some feldspar												
4	Like No. 6												
5	28			Ol.-And. 50	20		1		½	little	little		
6	15			Ol.-And. 5	72				7	½	½	little	
7	Like No. 5												
8	33			Ol.-And. 55	10		1			½	½	little	
9	40	15	4	Ol.-And. 5	5		30		½	little			½

A noteworthy feature is the fact that the strike of the foliation of the very gneissoid country rock is nearly at right angles to the gabbro-granite contact, while the clearly defined contact zones are parallel to the contact.

Other features of special interest are the syenitic border (except for the secondary biotite-schist) of the gabbro near the contact, and the almost complete absence of quartz from the granite within a dozen feet of the main contact. Thus the country rock (granite) is distinctly more basic near the contact, while the gabbro is distinctly more acidic near the contact.

Whether these interesting endomorphic and exomorphic changes are to be accounted for on the basis of assimilation of some of the country rock during the intrusion of the gabbro, or on the basis of the action of vapors from the intrusive, it at least appears quite certain that the gabbro must have been considerably superheated in order to have so notably affected the granite. As judged by the mode of occurrence of the gabbro stock, the stoping hypothesis recently advocated by Daly or the hypothesis of marginal assimilation might be applied to account for the more acidic border phase of the gabbro, but the sharp contact of the gabbro against the granite would seem to preclude the possibility of accounting for the more basic contact zones of the country (granite) rock on the basis of actual assimilation of some of the granite by the gabbro.

William J. Miller

SOCIETIES AND ACADEMIES

THE AMERICAN MATHEMATICAL SOCIETY

The nineteenth summer meeting of the American Mathematical Society was held at the University of Pennsylvania on Tuesday and Wednesday, September 10–11, extending through two sessions on Tuesday and a morning session on Wednesday. Twenty-nine members were in attendance. Ex-President H. S. White occupied the chair, being relieved by Professors E. S. Crawley and E. W. Davis. The council announced the election of the following new members: Professor W. A. Bratton, Whitman College; Professor Florence P. Lewis, Goucher College; Mr. Leslie MacDill, Indiana University; Professor H. W. March, University of Wisconsin; Mr. M. R. Richardson, University of Chicago; Dr. J. I. Tracey, Johns Hopkins University; Mr. H. S. Vandiver, Philadelphia, Pa. Five applications for membership were received.

On both days of the meeting luncheon was provided by the university. On Tuesday evening twenty-six of the members gathered at the usual dinner. The interval between the sessions was devoted to an inspection of the university grounds and buildings. On Wednesday afternoon several of the members made an automobile excursion about the city. At the close of the meeting a resolution was adopted expressing the thanks of the society for the generous hospitality of the university.

The following papers were read at this meeting:

R. D. Carmichael: "On the theory of relativity: analysis of the postulates."

F. H. Safford: "An irrational transformation of the Weierstrass γ-function curves."

E. L. Dodd: "The least square method grounded with the aid of an orthogonal transformation."

E. L. Dodd: "The probability of the arithmetic mean compared with that of certain other functions of the measurements."

H. Blumberg: "Algebraic properties of linear homogeneous differential expressions."

J. E. Rowe: "The relation between tangents and osculant $(n-1)$-ics of rational plane curves."

H. H. Mitchell: "Determination of all primitive collineation groups in $n(>4)$ variables which contain homologies."

Arthur Ranum: "Lobachefskian polygons trigonometrically equivalent to the triangle."

G. A. Miller: "A few theorems relating to Sylow subgroups."

Anna J. Pell: "Linear equations in infinitely many unknowns."

L. B. Robinson: "Invariants of two tetrahedra."

F. R. Sharpe: "The Klein-Ciani quartic."

F. R. Sharpe: "The $(2-1)$ ternary correspondence with a sextic curve of branch points."

F. R. Sharpe and F. M. Morgan: "A type of quartic surface invariant under a non-linear transformation of period 3."

S. Lefschetz: "Double curves of surfaces projected from S_4."

H. Blumberg: "Sets of postulates for the rational, the real and the complex numbers."

Oswald Veblen: "Decomposition of an n-space by a polyhedron."

F. N. Cole: "The triad systems of thirteen letters."

H. S. White: "Triple systems as transformations, and their paths among triads."

L. C. Karpinski: "Augrim stones."

Dunham Jackson: "On the approximate representation of an indefinite integral."

T. H. Gronwall: "Some special boundary problems in the theory of harmonic functions."

T. H. Gronwall: "On analytic functions of constant modulus on a given contour."

T. H. Gronwall: "On series of spherical harmonics."

O. E. Glenn: "A general theorem on upper and lower limits for the order of a factor of a p-ary form with polynomial coefficients."

E. J. Wilczynski: "On a certain class of self-projective surfaces."

The next meeting of the society will be held at Columbia University on Saturday, October 26. The San Francisco Section will meet at the University of California on the same day.

F. N. Cole,
Secretary

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MSS. intended for publication and books, etc., intended for review should be sent to the Editor of Science, Garrison-on-Hudson, N. Y.

THE STATE MUSEUM AND STATE PROGRESS[1]

It has been the good fortune of the people of this Commonwealth to have elected those men to preside over its interests who were positively instrumental in promoting science and learning, and who were especially active in promoting Agriculture, and the branches allied thereto. Your own recommendations and influence, touching these great interests, are highly appreciated by the people, as is evident from their united movements in establishing institutions which are designed to bear directly upon those objects, and which are specially designed to place them upon a scientific basis. (Ebenezer Emmons to His Excellency Hamilton Fish, Governor, Albany, December 25, 1851.)[2]

The citizens of New York and their representatives in the legislature are those especially addressed on this historic occasion rather than the distinguished company of scientific men gathered here for this celebration. While the present is a critical period in the moral and economic welfare of our people we predict that the twentieth century, which is still in its youth, is destined to reach its maturity with a far more general distribution of human happiness than the nineteenth. The unequal distribution of the good things of life is the underlying cause of all present social agitation, and by the good things of life we do not mean riches, but family health, food, sunshine, pure air, labor, the beauty of nature, the creative works of man. A redistribution will come about, not through politics which seems to

[1] Address delivered on October 15, 1912, to the citizens and legislature of New York State on the occasion of the opening of the new State Museum at Albany.

[2] "Natural History of New York, Part V. Agriculture," 4to. New York, Boston, Albany, 1851.

produce little except rivalry and bad feeling, nor through socialism which is essentially unnatural, but through the application to human welfare of all of nature's resources, known and still to be discovered. These resources are those of the Creator and therefore administer to our spiritual, intellectual and moral as well as to our bodily welfare. The great pathway to state progress is knowledge, obedience and unselfish utilization of the happiness which nature puts in our hands.

Our theme to-day is the part which the museum has exerted and is destined to exert toward this millennium of the twentieth century.

The rise of the museum as a new force in town, city, state and nation is the latest phase of educational evolution. The school, the college, and the university have gone in advance; the museum follows and is winning its own place and influence because it supplies a demand which none of its sister institutions fills. The very fact of this independent development is a proof that the museum is not one of the luxuries of civilization but an essential and vital force in the enlightenment of the people. Every community, small or large, needs its museum as it needs its schools and its churches. This rise, which is especially remarkable in certain cities of Germany and Austria, throughout England, and above all in the United States during the past quarter century, is largely due to what may be called the new museum idea, namely, that the museum is not a conservative but a progressive educational force, that it has a teaching quality or value peculiar to itself, that the museum succeeds if it teaches, fails partially if it merely amuses or interests people and fails entirely if it simply mystifies. The old museum idea was that of a sanctuary or refuge, a safe deposit vault for curious, rare, or beautiful objects which might be lost or destroyed; the ignorant visitor was tolerated rather than attracted, the curator was a keeper, not a teacher. The new spirit within the natural history museum is the educational spirit, and this is animated by what may be called its ethical sense, its sense of public duty, its realization that the general welfare of the people is the prime reason for its existence, that exploration, research, exhibition and publication should all contribute to this, that to serve a community the museum must reach out to all parts of nature and must master what nature has to show and to teach. The museum will flourish if the high educational service of the state is inscribed over its portals and instilled in the minds of every member of the staff from the highest to the lowest.

What renders this celebration a great one is that the ideal just sketched is largely exemplified in the New York State Museum, in the historic fact that the noble men of science and the wise rulers of our state have long been leaders in one of the great principles of museum development, namely, that the foundation of a state museum is mastery of the natural history of the state itself. In this regard since 1836 New York has been holding the torch for all the other states of the union. There has already evolved here that intimate union between a natural history survey, pure scientific research, a museum and the public welfare which the most enlightened communities in the civilized world have either attained or are striving to attain.

There remains to be developed by the Education Department through the museum the great work of spreading the beneficent products of this union throughout the public educational institutions of the state. This celebration is auspicious because it prepares the way for this new educational function of connecting the museum with the schools; this commodious building renders it possible for the first time in the history of the institution to expand along all the other lines of the new museum spirit, and directly and by extension touch the entire educational system of the state.

Thus we celebrate not the birth but the opportunity for renewed growth of an institution of which all the citizens of the state should be proud. Like the nautilus the museum moves into a new and beautiful chamber with its fine heritage, its ideals and its purposes unchanged: the shell is not the vital part, but it is highly favorable to the prolonged and expanding existence of the organism within.

In looking for the causes of the origin of this institution we find they are three-fold: first, the natural grandeur and interest of the territory of the state itself as a source of scientific inquiry and inspiration; second, the assemblage of an unusual number of scientific observers of the first order whom New York found among her own sons or attracted to her borders; third, a wise and liberal exercise of the powers of government on the part of the rulers of the state. It follows that our chief concern today should also be three-fold, namely: the preservation of this natural beauty as a continual source of inspiration and happiness to posterity, the birth and training of men and women capable and worthy of observing the laws of nature and spreading knowledge of them, the maintenance of standards of government equal to those of Secretary Dix who first outlined the survey, and of Governors Marcy, Seward, Bouck and Fish who promoted it.

As illustrative of the close union between science and good government two ancient episodes in the state's history may be recalled. One is that Samuel Latham Mitchell, the pioneer of natural science in this state, delivered an evening address before the state legislature, was elected to a seat in the legislature of 1790 and in 1807 took the first steam-propelled voyage up the Hudson with Fulton. Another is that in 1818, on invitation of Governor Clinton, Amos Eaton, the pioneer geologist of the state, delivered a course of lectures before the legislature and interested many of the leading men of the state in geology and its application to agriculture by means of surveys, thus planting the idea which eventuated in the great work, "Natural History of New York."

Is New York state to-day seeking among her votaries of science some of her representatives at Albany to counsel her in matters of state welfare? We may not answer the question but may put another: is the vast free educational system of the state, on which fifty-four millions of dollars are being expended annually, with a total attendance of one and one half million pupils, turning out its due proportion of men of science for the future service of the state? Whatever the answers to these questions, it is certainly well even on a jubilee occasion such as this for the members of a great democratic commonwealth like ours, full of confidence and pride in its institutions, dazzled perhaps by stupendous expenditures and vast numbers of students, to pause and consider which direction our social evolution is taking through education and democracy—progressive or retrogressive.

As regards the birth and education of men of science, the honor roll of geology in this state, the product of old educational methods, is a long one. We are impressed with what the state, the nation and more than this, the world owes to the generation born between 1764 and 1860 within our own state borders. Among the pioneers of science in this country were the following: Mitchell (1764–1831), born in Hempstead, L. I., whose political services have been alluded to above and who published in 1796 "A Report of the Geology and Mineralogy of the Hudson," the first work of its kind in the United States; Stephen van Rensselaer (1765–1839), born in New York City, founder of the Polytechnic of Troy, patron of the first serious geological work in the state; David Hosack (1769–1835), born in New York City, closely associated with De Witt Clinton in the leadership of civic life, promoter of botany and mineralogy, master of John Torrey; Amos Eaton (1776–1842), born at Chatham, turned toward science by Mitchell and Hosack, whose survey of Albany and Rensselaer counties marked an era in the progress of geology in this country, the master of James Hall; Henry Rowe Schoolcraft (1793–1864), born in Albany county, pioneer explorer of the geology and the mineral wealth beyond the Alleghanies and discoverer of the source of the Mississippi; John Torrey (1796–1873), born in New York City, pupil of Hosack, founder of American botany, master of Asa Gray; Joseph Henry (1799–1878), born in Albany, discoverer of the magneto-electric telegraph, which has put the whole world into communication; William Williams Mather (1804–1859), born in Brooklyn, one of the four geologists of the Survey, pioneer geologist of Ohio and Kentucky; James Dwight Dana (1813–1895), born in Utica, geologist of the Wilkes Exploring Expedition, the foremost geologist of his time in America; Alexander Winchell (1824–1891), born in the Northeast, geologist of Michigan; Othniel Charles Marsh (1831–1899), born in Lockport, famous vertebrate paleontologist, one of the leaders in the exploration of the western states; Robert Parr Whitfield (1828–1910), born in New Hartford, invertebrate paleontologist of distinction; Edward Orton (1829–1899), born in Delaware county, state geologist of Ohio; John Wesley Powell (1824–1902), born in Mount Morris, explorer of the Grand Cañon, famous ethnologist, director of the United States Geological Survey; Israel Cook Russell (1852–1906), born at Garrettsville, geologist, explorer and eminent writer.

We trust space may be found within the new museum, in bust or tablet, to memorialize the services of these great men as well as of those who, like Hall, came from other states. In this matter the state may well follow France, which leads the world in appreciation of its men of science and erects more statues to its savants and litterateurs than to its military leaders.

Among the living natives of the state who have rendered or are rendering distinguished service are Raphael Pumpelly (1837), geologist and explorer; John James Stevenson (1841), geologist of the Wheeler and Pennsylvania Surveys; Grove Karl Gilbert (1843), geologist of two state and two of the national surveys; Charles Doolittle Walcott (1853), leading invertebrate paleontologist and administrator of the United States Geological Survey and of the Smithsonian Institution; last but not least, John Mason Clarke (1857), pupil of James Hall, invertebrate paleontologist, distinguished in geology and paleontology.

From this number the nation has chosen two of the directors of the United States Geological Survey, Powell and Walcott, and two of the secretaries of the Smithsonian Institution, Henry and Walcott.

Our early political governors and men of science found their inspiration in the state itself, in its splendid area equal to that of all New England, in its scenery—including the Palisades, the Hudson, the Catskills, the Adirondacks, the Mohawk, Niagara, the lake and great western plains district—and in its diversity second only to that of California. Beautiful as the surface is with its flora and fauna, its interest, significance and utility have been vastly enhanced for man by the thorough understanding of its natural history and its prehistory, from the birth of the Adirondacks and Highlands to the final sculpturing of the state by the glaciers, with all the grand procession of life from the time of the interior paleozoic seas to the plants and animals of our day. For all this deeper knowledge we are indebted to the natural history survey of the state, begun in 1836 and practically continuing to the present time.

The Survey[3] was by far the most important scientific event in the history of our state and one of the most important in the history of the nation.[4] It attracted five of the most able geologists and naturalists of the country to its service, Lardner Vanuxem (1792–1848) from Pennsylvania, Ebenezer Emmons (1799–1843) from Massachusetts, from our state Mather, the geologist, and Torrey, the botanist, James Hall (1811–1898) from Massachusetts. The survey set a high standard not only for the state but for the country; it exemplified the ideal development, side by side, of pure and applied science. Emmons observed:

> The Survey of New York was indebted for its projection and execution to a movement in science —a movement which pervaded the entire thinking community. It was one of those natural results which mark the progress of truth; and itself was an evidence of the progressive intelligence of the human mind.

Hall observed:

> The enlightened spirit in which this Survey was directed, and the munificence with which it has been sustained, have afforded every means required for its completion. The state of New York, which has hitherto established her claim to the dignity of the Empire State, has now added another wreath to her laurels, in becoming the first in the patronage of science, and in the benefits thereby bestowed on her citizens, as she is first in resources, in commerce and public improvements.[5]

Mather observed:

> The State of New York is the first that fully carried out the principle of division of labor in the execution of a survey on the Natural History of the State, under the name of a geological survey. By this arrangement each head of a department of the survey has been enabled to devote his whole time and attention to his own specific duties, without having the entire range of natural science to distract his attention. . . . The survey of New York, unlike that of some of the other states, has been uninfluenced by party and political considerations, and the chief magistrates, during its execution, have been actuated by high and ennobling motives.[6]

Merrill observes:

> This led to an organization which has left a more lasting impression upon American geology than any that has followed or had preceded it. As fate ordained, the locality was one of the most favorable that could have been selected for working out the fundamental principles of stratigraphic geology; moreover, those appointed to do the work proved equal to the occasion. The New York survey gave to American geology a nomenclature largely its own; it demonstrated above everything else the value of fossils for purposes of correlation, and incidentally it brought into prominence one man, James Hall, who was destined to become America's greatest paleontologist.[7]

[3] It was the essay of John A. Dix as Secretary of State (1835) on the Natural Resources of the State that was the efficient final act before legislation was effected, a report prepared at the request of the legislature with reference to the organization of the Natural History Survey.

[4] See Merrill's "Contributions to the History of American Geology," p. 344.

[5] Hall, James, "Natural History of New York," Part IV., 4to, New York, Boston, Albany, 1843, p. ix.

[6] Mather, Wm. M., "Natural History of New York," Pt. IV., 4to, New York, Boston, Albany, 1843, p. x.

[7] Merrill, George P., "Contributions to the History of American Geology." Rept. U. S. National Mus. for 1904, pp. 189–734 (p. 344).

What was discovered by the original Survey fills thirty great volumes, stately and beautiful in form, epoch-making in content. The data in these works and the new series of thirteen "Memoirs of the State Museum," published between 1889 and 1910, are the units out of which, together with our present knowledge, the wonderful geologic history of the state with all its natural mineral wealth and other resources, its botany and zoology, can be written.

An outline of this history may serve the practical man as a brilliant instance of the union between pure and applied science, between theory and practice, but more than this it may show the lover of nature the new fascination and glamor which a knowledge of the past lends to the present.

Geology has shown that there are in New York state two great mountain uplifts or granitic sentinels surviving from the very beginning which are still centers of greatest beauty: to the north, as an outpost of the Canadian nucleus of the North American continent, lies the rugged mass of the Adirondacks, to be imagined as an island of ancient crystalline rocks, which has been above the ocean since the geologic dawn, its ancient mountains now worn down to their roots by erosion in succeeding ages and still flanked around the base by the old shore formations of the Cambrian and later periods. To the south lie the equally ancient Hudson Highlands and the rugged ridges of Westchester county, stretching southwestward from New England, the vestige of an eastern land mass of early geologic times which is now in large part sunk beneath the waters of the ocean or covered by more recent formations, the débris of struggles with the encroaching Atlantic. In this old pre-Cambrian continent, whose crystalline schists have been the special study of Kemp, are found our building granites, our magnetic iron, our rich deposits of talc and soapstone, sources of industry and welfare.

There were also two historic seas: the interior sea, or American Mediterranean, which bounded these granitic sentinels on the west, and the ancient Atlantic, which bounded them on the east. Our Atlantic coast line during the Paleozoic Period stretched far to the east, perhaps as far as the continental shelf, one hundred miles east of Long Island, where the depth then, as now, rapidly increased to the abyssal ocean.

There were also two great inclines or drainage systems, the first emptying into the interior sea which stretched from the south and west over a large part of the continent. During these early epochs central and western New York formed a battle ground between this inland sea and the granitic lands to the north and east; the shore lines advanced and receded, spreading the gravel beds and sands or the silt and calcareous ooze of the deeper waters in alternating succession over the broad plains of central and western New York. To the receptive basins of these shore lines of Silurian and Devonian age our builders largely owe their sandstones and limestones, their limes and cements. To the plant life imbedded in Silurian and Devonian times we owe our natural gas and our petroleum. Of Silurian age are our hematite iron ores. Great coastal evaporating basins of Silurian times have bequeathed to us our gypsum and our salt.

In the prolonged struggle the forces of uplift were finally victorious; the inland sea retreated step by step to the south and west until in the era of the great coal forest of Carboniferous times, the border line of permanent land has passed beyond the limits of what is now the state of New York. This is the reason the state has no coal. Throughout the central and western portion the rock formations still lie relatively flat and undisturbed; from the line of the Mohawk valley and the southern shore of Lake Ontario the successive strata rise tier above tier until they culminate in the Catskills to the east and the Pennsylvania border.

In 1836 James Hall was assigned this level and supposedly uninteresting portion of the state, the fourth district, which he was told "was good enough for a young man of twenty-five." The region was regarded as of little promise and was willingly relinquished to him, and this proved to be one of the happy accidents of geology, for Hall's genius revealed the fact that nowhere in the world does there exist so complete a series of the older fossiliferous rocks, such continuous records of the life of the ancient inland sea; in wonderful perfection the animals that lived in the shallow waters and along our inland coast have yielded the data for the paleontologic researches of the master and his pupils Merrill, Whitfield, Clarke, and others.

The second great drainage system, now represented by the vestigial Hudson river, is that which flowed from northwest and southeast between the northern and southern granitic masses of the Adirondacks and the Hudson. This broad trough, or valley, was developed east of the Appalachian uplift and included the Shawangunk[8] mountains. In it were accumulated the sediments washed down from the adjoining mountains during Triassic and early Jurassic times, to form the red sandstones and shales of the "Newark System," extending across the New Jersey border into Rockland county, and recently yielding at Fort Lee one saurian of Triassic age. The great red sandstone delta was in turn tilted and heavily faulted, and along the fault lines and between the strata of shale and sandstone welled up the great outpourings of basaltic lava which formed the trap rocks of the Palisades and parallel ridges to the westward.

Toward the close of the Age of Reptiles the littoral strip began subsiding beneath the Atlantic ocean, converting the shore line into a coastal swamp over Long Island; but the greatest factor in Long Island's history was the Glacial Epoch at the close of the Age of Mammals, when the ice cap extended downward from eastern Canada over almost the whole of New York state and left as its terminal moraine the long, irregular line of hills of boulder, clay and sand stretching along the northern shore of Long Island across Staten Island, New Jersey, Pennsylvania, and westward. To this we owe our building clays. This great ice sheet, as studied by Fairchild, Woodworth, and others, gave the final touch to our landscape and to our agricultural lands, gouging out valleys, blocking rivers, piling heaps of detritus across valleys during its slow retreat to the north, profoundly modifying the topography of the state, shaping the basins of many of our lakes, the courses of our rivers, and the character of our soil. At the beginning of the ice retreat the cap so blocked the St. Lawrence river valley that Lake Ontario found its outlet along the Mohawk river into the Hudson. All the life records of the

[8] The Shawangunk Mountains belong to the Appalachian uplift which succeeded the Carboniferous, hence very much more ancient than the later disturbances of the Highlands. The Catskill uplift belongs to the same age of general elevation as the close of the Carboniferous. It escaped the general reduction of the rest of the Alleghany Plateau for reasons not at present evident except in the hard nature of its rocks. The Hudson Highlands region has gone through its oscillations quite completely since the origin of the mountains referred to. The Highlands have gone far down after having been raised high, and are now apparently on their way up again. This statement relates to the relation of the Highlands to the cutting down of the Hudson River. (J. M. C.)

later geologic periods in New York state were swept away by erosion or buried beneath the débris of the Ice Age. Only from the swamps and peat bogs formed since the retreat of the ice have been disinterred the skeletons of mastodons[9] and other extinct forms.

Science, like charity, begins at home. Our Education Department could not do a wiser thing than to popularize the technical geology of the state in a school book and put such a volume into the hands of every scholar; it would exert a vast influence.

The animal and plant life of the state formed the second great branch of the Survey. As a result New York state has taken a leading part in the encouragement and development of the study of birds in this country, from 1844, when the state issued a quarto volume of 380 pages and 141 colored plates by James E. De Kay, "On the Birds of New York," to 1910, when it published the first of two superb quartos by Eaton with colored plates by Fuertes; and here again the Survey has been more or less directly the means of bringing out the latent ability of sons of the state. Among the ornithologists, all natives of New York, who have been developed during this period, are Giraud, Mearns, whose researches have extended all over the union and to Africa, Merriam, head of the U. S. Biological Survey, and our leading field naturalists, Bicknell, Ralph, Bagg and many others.[10]

The Survey also produced in 1842 De Kay's four volumes devoted to the mammals, reptiles, and amphibians, also the extinct mammals of the state as they were known in 1842. Later contributions to the mammalian life independent of the survey were Merriam's "Mammals of the Adirondacks," 1882 and 1884, Miller's "Preliminary List of the Mammals of New York" in 1889, and Mearns's "Mammals of the Hudson Highlands" and "Mammals of the Catskill Mountains."

The practical results growing out of the State Survey are no less significant than the theoretical, affording the strongest proofs that discovering and spreading knowledge of nature is the best investment a state can make, because all wealth and all health flow from such knowledge. When state funds are used for the forces which make for production the payment of interest is retarded, perhaps beyond the lifetime of the individual who makes the discovery and when returns do come the discoverer is often forgotten; only in rare instances does he benefit from them. The chief applications of the results of research have been to agriculture and mining; in fact, the science of agriculture was one of the original motives in the organization of the Survey, and the four volumes which Ebenezer Emmons devoted to the agriculture of New York and to its fruit culture between 1846 and 1854 led to the organization of the State Agricultural Society and finally to the State Agricultural Department.

The increase in the value of the mineral product[11] of the state since the organization

[9] Mastodons and mammoth remains are found in swamps and beaches of the same age, though the occurrence of the latter is comparatively rare; they are contemporaneous, but it is probable that the mastodons survived the mammoths within our area. (J. M. C.)

[10] C. Hart Merriam, New York City, 1855; Edgar A. Mearns, Highlands Falls, 1856; E. H. Eaton, Springville, 1866; E. P. Bicknell, Woodmere, L. I.

[11] Mineral productions of the state—

	1837	1911
Iron ores from within the state	1,000,000	3,184,054
Clay materials	150,000	9,734,744
Building stones	500,000	5,520,800
Salt	625,000	2,191,485
Gypsum	15,000	1,092,598
Cement	150,000	3,065,334
Materials not produced in 1837		6,784,093

of the Survey has been approximately 3,000 per cent. The fact speaks for itself without claiming for the geological organization all the credit for this tremendous development. The approximate output of minerals of all kinds for the year 1837, the first year in which the Survey did actual work, was two and one half millions; the total mineral production for the year 1911 for materials within the state was thirty-one and a half millions; but including the ores brought in from outside the production is seventy-four and one half millions, ranking New York state as the sixth state of the union in the value of its total output. The preeminence of Pennsylvania, Illinois, Alabama, and West Virginia is due to their coal, that of California to its oil. As a result of the careful surveys made within the last few years the volumetric totals of the iron ores still available for commerce are shown to reach nearly one billion tons, interesting as indices of the potential natural wealth of a state which has no coal and comparatively little oil. The scientific foundation of this development is the volume "Mineralogy of New York," by Lewis C. Beck, published in 1842.

The most recent instance of the interrelations between pure science and progress is that developed by the need of the City of New York for an increased water supply, involving the second greatest engineering task of modern times. When work on the new aqueduct was actively undertaken ten years ago, the chief engineer, J. Waldo Smith, one of the broadest minded men of his profession, realized that the geological structure and the present and past history of the region to be traversed entered in a fundamental way into the problem. The region embraces the Triassic and Archean formations of the state from the Upper Devonian downward, formations to which the survey has devoted pure research since 1836, formations folded, faulted, and metamorphosed in a most complicated manner. The surface features are concealed everywhere with drift of the Glacial Epoch, which at places like a thick mantle covers buried channels or pre-glacial systems of drainage which cut the bed rock to depths much below the present level. At the Storm King crossing of the Hudson the rock bottom is 800 feet or more below the surface of the river. With their thorough understanding of these facts, the consulting geologists Kemp, Crosby and Berkey aided the engineers in selecting the best locations and in forecasting the underground geology for the preparation of specifications for the contractors. Conversely the great tunnels and sections of the engineer have laid bare new matters of great value to the geologist; matters of inference have become the recorded facts of observation; estimates have given way to precise measurement in feet and inches. All this experience, embracing so much of human, scientific, and technical value, is to be brought together in a volume by Berkey and published with abundant profiles and illustrations in a bulletin of the State Museum.

The scientific growth of New York state is the past, the present, and a forecast of the future of our State Museum. The offspring has become the parent; the museum now conducts the geological and other surveys of the state. From its slow birth under the Natural History Survey between 1836 and 1843, under vicissitudes of name, of scope, of direction, and of dwelling place, the State Museum is now the titular head of the survey and of the entire science division under the New York State Education Department. The paleontologic, geologic, mineralogic, and botanic departments, independent offshoots of the survey, were brought under the regents of the university in 1883, and in 1889 the museum was made an integral part of the University of the State of New York. A further concentration took place in 1894 when the university was fused with the New York State Education Department, under which a division of science was created. This division was charged with the broad powers of administration of the museum and with the geology, paleontology, botany, entomology, zoology, and archeology; in brief, it is the scientific scope of the old Natural History Survey of 1836 with the added custodianship of all the materials brought in. As compared with our central government, it is the United States Geological Survey, a part of the Agricultural Department and the National Museum swept into one under a bureau of education. Such unification is, so far as we know, unique; it is certainly logical in the sense that all state-supported scientific work should be *educational* in the very broadest sense as well as in the interests of pure research; as an administrative system it is an experiment which is well worth trying by our state, for it may be of value in Washington, where concentration of all the scientific bureaus of the government has long been under consideration.

Under the directors Hall, Smock, and Merrill in the years that have passed since 1904, the date of the appointment of John Mason Clarke as head of the museum and of the survey, the historic lines of geology and paleontology have been ably sustained, lines which are among the most honored traditions of the institution, together with greater activity along lines which had not been especially developed in its previous history. Thus while the study of plant and insect life has followed the earlier lines of economic service to the state, there has been continued advance in the study of mammal and bird life, of the past and present life of the Indian. Every effort is being made to represent in full in the museum the fauna of this state and to exhibit it as effectively as practicable. In archeology the unique field is the study and portrayal of the culture of the Iroquois, which brings the museum in touch with the 6,000 Indians of the state, their history, ambitions, and ideals, and it is fortunate that the preservation of the traditions and the folklore of this declining race is entrusted to the State Museum. Following up the work of Lewis H. Morgan, who probably contributed more to initiating and advancing anthropological work among the Indians of the state than any other person, there were the writings of Beauchamp and the studies of Converse, while among the younger contributors may be mentioned Parker, the present state archeologist, and Skinner.[12]

The law also provides that the State Museum shall cover the field of history, and the initiation of this problem is large because it has hitherto been entirely neglected by the state and important because of its educational bearings.

The original function of the museum as a depository of all the scientific materials brought in by the survey should be extended along lines similar to those followed by the National Museum of Washington, so that the new Conservation Commission with its interests in the forests, the fisheries, and the game of the state shall find the rooms of the State Museum equipped for the scientific materials which come to the commission. Similarly the department of the state engineer, the departments of agriculture, of health, and highways, should regard the halls of the museum as the place where the people are to find the visible educational materials developed with the growth of these several departments. This cooperation is in keeping with the unifica-

[12] Harriet Maxwell Converse, Arthur C. Parker, Alanson Skinner.

tion of the advance of pure and applied science in the progress of the state.

We may well ask what are the distinctive features of an ideal state museum as contrasted with great civic museums like the American Museum of Natural History of New York, the Field Museum of Natural History of Chicago, the Carnegie Museum of Pittsburgh, or a great national museum like that in Washington? Why should a state have its own museum, apart from the historical and political reasons which have located this institution at Albany? The answer is largely given in the preceding portions of this address. The museum is the natural scientific center of the state government; it is the natural depository of all the material brought together by the state surveys, it is the natural custodian of all purely scientific state records; it is the natural center of the study of the resources of the state as a political unit; it must maintain its capacity for productiveness in pure scientific research—pure science has been the justification of the state museum from the beginning of its history. For example, it is justified in issuing a monograph on the birds of New York state, as it is now doing, because this kind of publication belongs to the museum historically, because the education of the people of the state in the important matter of the economic value of bird life must be accompanied by the preservation and exhibition of the materials on which the volume is based. In brief, the distinctive sphere and scope of the state museum corresponds with the scientific interests and welfare of the people within the geographic boundaries of the state.

Yet in no relation is the function of the state museum more full of promise than in its relation to state education, a relation which it already maintains but which should be greatly extended in the future. The peculiar teaching quality of a museum is that it teaches in the way nature teaches, by speaking to the mind direct and not through the medium of another mind. This principle of natural instruction is being carried out in the development of the exhibits of the museum, and through photography these exhibitions may well be extended to the schools of the state. The museum should be the center from which the visual and practical instruction of the children of the state in science should emanate. The pulse of the new museum should be felt in every country school in the state and in the schools of every one of its cities which has not developed its own museum center. The museum should supply the schools with collections of scientific materials; it should distribute traveling demonstrative collections in natural history. In brief, it should supply the State Education Department with all materials for the visual instruction in the scientific features of the state for distribution among the schools. Our school children should receive their first inspiration in science not from abroad but from the things about them. There is every reason why the state museum should do for the resources of the state what the Commercial Museum of Philadelphia is doing for the people of Pennsylvania.

The execution of these ideals requires a combination of scientific and administrative ability with a strong sense of public duty, which I dwelt upon in the opening paragraphs of this address. Our great commonwealth is to be congratulated on having at the head of its educational system a man of the breadth of view of Dr. Andrew S. Draper, and at the head of this institution a man of such thorough preparation, wide sympathies and executive ability as its present director. In assuming the centralized control both of the Geological Survey and the State Museum in 1904 Dr. John Mason Clarke inherited positions rich in traditions and undertook no light task. Long years of experience as an assistant to James Hall had given him a wide and thorough knowledge of the state's geology and paleontology, and, quite as important, of its legislators. Although a paleontologist and stratigrapher himself, all the other lines centering in his office have received his support. While the great monographs on the faunas of the Devonian, the graptolites, the ancient sponges and the eurypterids have seen the light, the areal geology has had its full recognition, the ancient crystallines have received no less attention than the fossiliferous beds and the mineral resources. Botany, zoology and archeology have had their due and are well represented in the publications of the state museum. The geologic map of the state has progressed on the topographic scale of one mile to the inch, so far that almost one half of the area of the state has been plotted in minute detail. The museum has kept in touch with and published the geological results obtained in connection with the development of the aqueduct. It has availed itself of the cooperation of many of the most able specialists in the state.

It is now the great opportunity of our state not only to maintain liberally a museum the purpose of which is to present in fulness the character of its natural resources, but to furnish the State Department of Education with the means of spreading the work of the museum in popularized form throughout the schools of the state. The appropriations have doubled in recent years, now amounting approximately to $40,000, but they are insufficient to develop a museum worthy of the dignity of the state of New York either along the lines of exhibition or those of public education.

The truest measure of civilization and of intelligence in the government of a state is the support of its institutions of science, for the science of our time in its truest sense is not the opinions or prejudices, the strength or weakness of its votaries, it is the sum of our knowledge of nature with its infinite applications to state welfare, to state progress and to the distribution of human happiness.

Henry Fairfield Osborn
American Museum of Natural History

ADDRESS OF PRESIDENT TAFT AT THE FIFTEENTH INTERNATIONAL CONGRESS ON HYGIENE AND DEMOGRAPHY[1]

It is my pleasant and honorable duty, on behalf of the people and the government of the United States, to welcome this great congress to Washington.

"Prevention is better than cure." The science of medicine and surgery has made wonderful growths in the last forty years, but in that time it would seem as if the science of sanitation, of hygiene and of preventive medicine had come into being from nothing. And now the two, prevention and cure, through the intense energy, industry, application, keen discrimination and high and enthusiastic aims of the benefactors of human kind, who are now devoting their lives to research, and the investigation of the cause of disease, its transmission and its antidotes, are proceeding, *pari passu*, with such rapidity and success that in the next century we may almost expect to find the equivalent of that fountain of youth and perpetual life which was sought for in this country by some of the early discoverers.

It is easy to make an error with reference to the beginning of a great forward movement by dating it from the time when the

[1] Official report of the address given at Continental Memorial Hall, Washington, D. C., September 23, 1912.

would-be historian has become alive to its progress and convinced of its importance. Now, I do not mean to say that our sanitary science in this country began with the Spanish war; I do not mean to say that it had its origin in the tropics; for I have no doubt that nearly every one who hears me could confute such statements, by reference, for example, to the robbing of dread diphtheria of its terrors by antitoxin and other similar revolutionary discoveries. And yet it is true that out of a war, very short of duration, and of comparatively little importance in the number of men engaged, and the cost, and the lives lost, there came to this country a series of problems, the most important of which included questions of sanitation, the methods of transmission and the cure of tropical diseases, the adoption and enforcement of a system of hygienic law, and the establishment in the tropics of governmental institutions of medical research by army, navy and civilian physicians, which have brought to the attention of the whole country the necessity for widespread reform in our provisions for the maintenance of health and the prevention of disease at home.

Our responsibilities in Cuba, Porto Rico and the Philippines, and now on the Isthmus of Panama, have so enlarged our knowledge of the possibilities of successful sanitation under the most burdensome conditions, and have so impressed both professional men and the laymen at all familiar with conditions, with the necessity for more rigid and comprehensive health laws, and a stricter enforcement of them for the general public good, that if the Spanish war resulted in nothing else, it was worth greatly more than it cost, in this useful development of one of the most important functions that modern government has to discharge, as well as in making clear the need of an additional branch of general education in the matter of the hygiene of the home and of the individual.

It would seem as if the tropics were the proper place for the beginning of a crusade on this subject. In the tropics nature has a more rapid growth, not only in vegetation and in animal life, but the diseases are shown on a larger scale and permit the study of their development with more certainty of conclusion than in the temperate zone. The effect of preventive regulation upon great bodies of persons is more clearly marked, and the reward for hygienic strictness seems greater and more obvious. When we first went into the tropics, our purpose was to make that region habitable for white people. We have demonstrated that as a possibility. Now we have gone beyond the provision for those who come from the temperate zone, and we are engaged in the work of developing the tropical races into a strength of body and freedom from disease that they have never had before. The prevalence in a whole race of the hookworm, or of malaria, or of beri-beri, the persistence in the intestines of an entire population of many varieties of disease germs which do not destroy, but weaken and stunt and shorten life, shows the possibility by proper health methods and proper treatment of revitalizing tropical races and securing from them that vigor of physical action which will enable them to develop and enjoy the marvelous richness of the countries in which they live. Of course the problem of enforcing health regulations against the will of an ignorant people, whose natural laziness and resentment at discipline makes the enforcement most difficult, requires a strong government and the raising of a sufficient fund by taxation to maintain an adequate health police. These are the problems in the tropics that every government that has dependencies must meet. There is no difficulty about running a government cheaply if you limit its functions to the mere matter of the preservation of peace and the administration of justice; but if you propose to add to these adequate systems of education, government hygiene, good roads, and other internal improvements, then you must look about for sources of revenue which are not always forthcoming, and an absence of which retards the progress that every good administrator longs for in the interest of the people entrusted to his charge. And then if the government to be established is to be more or less popular, the people themselves must be educated to understand the importance of the hygienic restrictions, to accept them, and themselves to impose upon themselves the burden of taxation which it is essential for them to carry in order that any progress shall be made at all.

I consider it a proud record of the American army that through its medical corps engaged in hygienic work, so many important discoveries as to the transmission of disease and the method of stopping its spread, have been given or proven to the world, and all of this is dated chiefly from the time of the Spanish war. The elimination of black smallpox by thorough vaccination, the study of bubonic plague, its mode of transmission, suppression of its causes and its methods of treatment, the study of cholera and its method of treatment, together with the preventive inoculation, the study of beri-beri, and the methods of its prevention and cure which have not, even as yet, been altogether satisfactory, the learning of the causes of yellow fever by transmission through the mosquito and its method of treatment so as by isolation of both the patient and the mosquito to prevent its spread in a community, and its ultimate suppression, the minimizing of the bad effects of malaria by the destruction of the mosquito which carries its poison, the ridding a race of the hookworm and its demoralizing physical degeneration, the prevention of typhoid by inoculation, all constitute great steps forward in the treatment of diseases that though most of them are especially formidable in the tropics, are general also in the temperate zone, and in these discoveries which have been made, it is most satisfactory to be able to say that our American physicians have taken and are taking a most important and honorable part. It is very certain that but for these discoveries the construction of the Panama canal, which now since 1904 has been going on with giant strides, and which will be completed within a year, would have been impossible. The effort of the French to build a much smaller canal at the same place would doubtless have been successful but for the problems of hygiene which the science of that day did not enable them to solve. And now it is proper that the chief health officer in charge of that strip forty miles long by ten miles wide, who has enabled 50,000 people to live there in health and build the canal, should share with the chief engineer the honors when the end shall crown the work. It was most fortunate in working out the problems that these agents of health on the Isthmus had no limitation put upon them with respect to expense, and that everything was at their hand to accomplish the purpose of the nation. Other problems which shall arise in the future may not be so fortunately circumstanced, and economy and the limitations of expense may call attention to the necessity for finding changes in method which shall reduce the cost of the work and bring it within reasonable figures, but it is well that the first effort was not hampered by such considerations. Of course, while the great problem was the problem of the maintenance of the healthfulness of the Isthmus during the construction of the canal, there still remains the important one of keeping the strip healthful while the canal is operated.

The possibilities of improvement through governmental hygiene of tropical countries are so great that it makes one who has any conception of what they are grow enthusiastic in the contemplation of what centuries may bring forth in this regard. Of course, one of the things that will have to be brought about is effective and efficient government in the tropics, and how this is to be reconciled with the growing tendency toward more and more popular government is a question of the education of the people in governmental responsibility. Still the amount which can be done in the enforcement of principles of hygiene with the tropical races and with those who live in the tropics, has already had sufficient demonstration to make one with any imagination at all anxious to look forward to the development of the world around its middle after the temperate zone shall have been occupied to such an extent as to make the enterprising of their inhabitants look elsewhere for migration and settlement. The mere matter of the improvement of people in the Philippines by the establishment in each village of artesian wells, so as to give them pure water, gives such a marked decrease in the mortality and such a marked increase in the health of the inhabitants as to show a present condition that is capable of wonderful amendment.

I have dwelt at length upon the tropical hygiene because my responsibilities have brought me more into contact with that than with the hygienic problems of the temperate zone, where improvement in conditions is necessarily less marked, because the conditions are not so deplorable when attacked. The range covered by the considerations of this congress is so wide as to be almost bewildering, and the problems which are presented in working out the improvements toward the ideals that are presented are of course most various and most complicated. The question of the interference with personal liberty through the insistence upon the enforcement of health regulations does not present itself in the temperate zone so often as in the tropics, because the prevalence of infectious and contagious diseases in the form of an epidemic is not so great; and yet, as we go on to regulate how people shall live, we may expect to find, as indeed we have already found, considerable resistance and inertia that requires care and caution in the drafting of drastic regulatory provisions. Then the expense of the maintenance of a force sufficient to carry out useful regulations is a most serious question in carrying on a proper government. The number of things that the government has to do has increased so rapidly under the modern view that the necessity for economy in administration was never greater, while the burden of taxation continues and must continue to increase.

I do not doubt that we are beginning a new epoch in humanity's history in this country in reforms looking to the bodily health of those less fortunately circumstanced in their life's condition and work. The study of vital statistics showing the prevalence of diseases and tracing their causes must prompt the organized effort of governmental forces to minimize the causes, and to furnish remedies for the evil. We have already begun the reform, in our pure food law, in our mining bureau and our children's bureau.

We must initiate investigations into diseases of particular occupations with a view to regulation or prohibition. An example of this we have in the heavy tax upon the making of white sulphur matches. Still greater opportunties for improvement are before us. We need to develop under governmental auspices a bureau or a department, in which the funds of the government shall be expended for research of every kind useful in the practise and enforcement of hygiene and preventive medicine. That something of this sort may grow out of the present United States Public Health Service there is reason to believe, but it will need far greater appropriations and a widening of its scope of duties before it shall have filled the place that the medical profession of this country has a right to expect the general government to create in the progress of hygiene and demography.

I have said little or nothing about the vital statistics, not because I would minimize its importance, but because my information in respect to it is so faulty. I am very certain that we are far behind other countries in the completeness of our vital records, because we are a new country, and we have not stopped to make the needed registers of lives and deaths and diseases and in the hurry of our existence we have failed to appreciate the enormous value that attaches to such statistics in the study of improving methods and the ascertainment of facts essential in the development of hygienic science.

I can not conceive any congress of a more useful character than the one which it is now my honor to welcome. It is useful, first, because a comparison of the ideas and the discoveries and the theories of men engaged in the same hunt for truth, and in the same delving into the mysteries of nature, with a view to wresting her secrets in the matter of the cause and cure of disease, must result in a general benefit to all who take part in such a congress. The science of hygiene and sanitation and demography must be given an impetus the world over by the temporary concentration in close quarters of men from all the world who have been giving their life work to the same problems. It is delightful to contemplate this phase of the congress, because it is one of those shining instances of worldwide organization for the promotion of the peaceful arts, of which I am glad to say the number is growing every year, and in which the common interest of humanity is made conspicuous by contrast with the selfishness and isolation of each nation in the conflict of interests that are typified by our burdensome and ever-increasing preparations for war. Such congresses can not but make for the permanence of peace. They must create a deeper love of man for man. They do stir up in the membership of such a congress, having representation from all the world, a greater human sympathy, and offer to the scientific student who is willing to devote his life to the development of a truth that shall add to the health and comfort and happiness of his fellows, a reward that can not be measured in money but is to be found only in the consciousness of the highest duty well done. But while these things are true with respect to the world effect of such a congress, its local influence upon a country like the United States is much more marked and important in the impetus that it gives to all who are responsible for the health of the community either in their profession or by reason of their official and governmental responsibility. They must have in such a meeting as this, their ideas and their knowledge enlarged, and they must derive an inspiration for better and more enthusiastic work from the commingling of the greatest scientists of the world here, and their exchange of views, and from the very energizing atmosphere of the congregation. I should think that such a congress as this would increase the number of novitiates for the profession of medicine and surgery. Within the last fifty years, no profession has shown such progress, no profession has come near it in the development of its importance for the promotion of the health and comfort of mankind; no profession has offered to its devotees, in such measure, the priceless reward that comes to any one who has wrested from nature one of her secrets and by disclosing it to his fellowmen has furnished a means for their happier lives.

I congratulate the medical profession of the United States upon this great congress, whose coming here is due largely to their initiative, and the membership of which in large part represents the medical science of the world.

Ladies and gentlemen of the Fifteenth International Congress on Hygiene and Demography, I welcome you to America. I welcome you to Washington. I sincerely hope that your stay here may be as pleasant and agreeable as I am sure it will be useful to this country and to the world.

TWELFTH ANNUAL INTERCOLLEGIATE EXCURSION OF NEW ENGLAND

The twelfth Intercollegiate Excursion will be held in the vicinity of Meriden, Connecticut, under the direction of Professor W. N. Rice, of Wesleyan University.

Members of the party are invited to visit the geological and mineralogical collections of Wesleyan University, in Middletown, on the afternoon of Friday, October 18. At 6:30 P.M. a collation will be served in Fisk Hall, Wesleyan University. At 7:30 P.M. a meeting will be held in the lecture room of the Scott Physical Laboratory. A lecture illustrated with lantern slides will be given by Professor Joseph Barrell, of Yale University, on "Central Connecticut in the Geologic Past." After the meeting, the party will go by trolley to Meriden, and spend the night at the Winthrop Hotel. The price of lodging at the Winthrop Hotel for members of the party will be one dollar. Breakfast à la carte.

At 9:00 Saturday morning, October 19, the party will take a special car for Westfield. The trolley line follows in general the line of the great fault between Higby Mountain and Lamentation Mountain. The return from Westfield to Meriden will be made partly on foot, and partly by the special car which will be waiting at various points along the route.

Attention will be called to the drag dips and other evidences by which the line of the fault can be traced. The topographic effect of the fault can be seen very satisfactorily from the south peak of Lamentation, which will be ascended. The party will visit the site of the once picturesque Westfield Fall, and its little post-Glacial gorge. In a railroad cut near Westfield three small faults marked by drag dips can be observed. In the same vicinity can be seen evidence that the posterior trap sheet, at least in that vicinity, is a double sheet. Lunch will be taken at the club house at Highland. Price, seventy-five cents. Party will arrive at Meriden at 5:13 P.M.

The route is on the Middletown and Meriden sheets of the Topographic Map of Connecticut. Reference may be made to Davis's paper on the "Triassic Formation of Connecticut," in the 18th Annual Report of the U. S. Geological Survey, and to Rice and Gregory's "Manual of the Geology of Connecticut," Bulletin 6 of the Connecticut Geological and Natural History Survey.

Meriden is on the N. Y., N. H. and H. R. R., between Hartford and New Haven. Middletown can be reached from Hartford or New Haven *via* Berlin, from Hartford by the Valley Branch or by trolley, from New Haven by the Air Line, from Meriden by trolley.

Every one is earnestly requested to inform Professor Rice as early as practicable, whether he will be present at the lunch in Fisk Hall Friday evening, and whether he wishes to engage lodging at the Winthrop Hotel, as well as whether he will be in the party on Saturday.

Herdman F. Cleland,
Secretary

Williamstown, Mass.,
October 5, 1912

THE STUDY OF MALARIA

The first expedition from the Tulane University School of Tropical Medicine to the tropics for the study of malaria was made possible through the kindness of an unknown friend of the school who, through Dr. Isadore Dyer, dean of the medical department of Tulane University, contributed a fund to finance the project.

The United Fruit Company, who have already contributed $25,000 towards the expenses of the School of Tropical Medicine, placed their steamships and other equipment at the service of the school for the transportation gratis of the expedition and apparatus. Colonel W. C. Gorgas, chief sanitary officer of the Panama Canal Zone, with various members of his staff, placed all the material in his hospitals at the disposal of the expedition and extended every possible courtesy.

The personnel of the expedition consisted of two members of the school, Dr. Charles Cassedy Bass, assistant professor of tropical medicine and hygiene, and Dr. Foster Mathew Johns, assistant in the laboratories of tropical medicine and hygiene.

The object of the investigation was the cultivation of the malarial parasites *in vitro* which had already been accomplished by Professor Bass, but many details of which remained to be elucidated and confirmed.

In this the party obtained complete success. It was found that the malarial plasmodia can be grown in human serum, in Locke's fluid (from which calcium chloride is omitted) and in human ascitic fluid. In the majority of the cases dextrose must be added to the medium to secure satisfactory growth. The most favorable temperature for the cultivation of plasmodia is about 40° C.

Positive cultures were obtained from 29 cases of æstivo-autumnal malaria, 6 cases of tertian and 1 case of quartan. Cultures were carried on for four generations from the parent culture before the expedition left Central America, and can probably be maintained indefinitely.

The full report of the expedition may be found in the October number of the *Journal of Experimental Medicine.*

In addition to these researches the school has also carried out experimental work on pellagra, leprosy, beri-beri, blackwater fever, filariasis and other tropical diseases, which work will be found in the forthcoming first report of the school.

The school is under the direction of Dr. Creighton Wellman, formerly of West Africa and the London School of Tropical Medicine.

It is an integral part of the medical department of Tulane University of Louisiana, and begins its second year of existence with bright prospects.

THE ESKIMOS OF CORONATION GULF

The Stefansson-Anderson expedition to Arctic America was organized in 1908 and sent out under the auspices of the American Museum of Natural History. The expedition was in charge of Mr. Vilhjalmr Stefansson, a graduate of Harvard University, and Dr. R. M. Anderson, of the University of Iowa. Mr. Stefansson devoted his attention to the anthropological work of the expedition, while Dr. Anderson was occupied with the zoological work.

Between May 13, 1910, when he first came in contact with the Eskimo of Cape Bexley, and May 18, 1911, when he left the Prince Albert Sound people to return to his base near Cape Parry, Mr. Stefansson saw about a thousand persons, roughly speaking. He took cephalic measurements of 206 of these.

It appeared both to Mr. Stefansson himself and to the Alaskan and Mackenzie River Eskimo who accompanied him on this journey that the people visited differed considerably in physical characteristics from any Eskimo they had seen previously. Perhaps the most striking feature was that beards were not only more common and more abundant than among the men of the western Eskimo, but also of colors varying from black to a very light brown tending to red.

The blond tendencies are most prominent in southwestern Victoria Island, but they are met with at least as far east as a hundred miles east of the mouth of the Coppermine River, Coronation Gulf. Although no scientific census was taken to determine the exact degree of blondness of every individual seen, Mr. Stefansson feels safe in saying that more than half the individuals seen have eyebrows lighter than black and ranging all the way to a very light brown. The tendency to blondness seems less strong in the women than in the men. A few individuals had curly hair and perhaps a dozen had eyes noticeably lighter than the ordinary Eskimo brown, ranging to blue or blue-gray.

These and other facts of a similar character were observed by Mr. Stefansson and will, in due course, be published by the museum. It is too early to settle definitely on any theory explaining the facts. Of the various explanations that have so far been suggested it seems to Mr. Stefansson that the one open to the fewest serious objections is that of the admixture of a large amount of European blood at some fairly remote period. In this connection the disappearance in the fifteenth or sixteenth centuries of the Norse colony from Greenland suggests itself as a possible source of the European-like characters. Many things militate against the supposition that they can be derived from any of the Franklin expeditions of the middle of the last century; one of these is that the only Eskimo of this district seen at close quarters by Franklin himself is described by him in terms which fit very well the blond type found to-day ("Narrative of a Journey to the Shores of the Polar Sea in the Years 1819–1822," by John Franklin, Philadelphia, 1824, p. 316). The purely biologic theories that might explain the facts also seem to have their serious drawbacks.

RETIREMENT OF PROFESSOR HENRY SHALER WILLIAMS

Professor Henry Shaler Williams, of the department of geology of Cornell University, has retired from active teaching and has been appointed professor of geology, emeritus. In making the appointment the Board of Trustees adopted the following resolution:

> The trustees of Cornell University desire to record their appreciation of the long and varied services of Professor Henry Shaler Williams and their regard for his high personal character.
>
> A graduate of Yale University in 1868, he was afterwards in the service of that university and professor in the University of Kentucky. His connection with Cornell University began in 1879, when he was appointed assistant professor of geology, becoming later professor of geology and paleontology. He also discharged the duties of secretary of the faculty and was dean of the general

faculty from 1887 to 1892, when he was called to his alma mater as Silliman professor of geology. During this time he maintained as later an intimate connection with the United States Geological Survey and was associate editor of the *American Journal of Science* and *Journal of Geology* and a frequent contributor to other learned periodicals and societies.

In 1904 he was recalled to Cornell University as professor of geology and continued his work with the United States Geological Survey. He now retires to accept a pension under the Carnegie Foundation. The trustees desire to repeat the cordial expression of their appreciation of his ability and fidelity to the university which they recorded on his resignation in 1892. They further express the hope that he may long enjoy the facilities of the university to which he has generously contributed and continue his distinguished services to geological science.

SCIENTIFIC NOTES AND NEWS

Dr. Alexis Carrel, of the Rockefeller Institute for Medical Research, has, according to cablegrams from Stockholm, been awarded the Nobel prize in medicine. Dr. Carrel, who was born in France in 1873, has carried forward important research work in experimental pathology, physiology and surgery.

Sir W. T. Thiselton-Dyer, F.R.S., has been elected an honorary fellow of the Royal Society of South Africa.

The Academy of Natural Sciences of Philadelphia has appointed Professor Allen J. Smith and Professor Hugo de Vries delegates to the dedication exercises of the Rice Institute, and Professor Henry Fairfield Osborn a delegate to the dedication exercises of the New York State Education Building.

Professor Dugald C. Jackson, head of the department of electrical engineering of the Massachusetts Institute of Technology, has been given leave of absence until January first and has gone to England at the British government's request. When the English Post Office Department considered the purchase of the different telephone lines, it determined to call one authority outside the country to work with the English commission. The selection of the government was Professor Jackson, who is now called to England for the final work of appraisal.

Professor W. J. Hussey, director of the Detroit Observatory of the University of Michigan, is at present engaged, as has been reported in Science, in the reorganization of the Astronomical Observatory of the University of La Plata, Argentina, of which also he is director. Professor Hussey was granted eighteen months' leave of absence from Michigan last spring in order that he might carry forward the plan of cooperation between the observatory at Ann Arbor and the similar institution in the southern hemisphere. He left for the south last June and since that time has been followed by Messrs. P. T. Delavan and B. P. Dawson, both of whom have been trained in astronomical work at Michigan. Mr. Delavan returns to Argentina, where he was a member of the Carnegie expedition for the observation of fundamental stars in the southern hemisphere. The fourth member of the present expedition to the La Plata Observatory was Mr. H. J. Colliau, the Detroit Observatory instrument maker, who sailed on August 20 to join Professor Hussey and assist in the reconstruction of the instrumental equipment of the southern institution. With Mr. Colliau went a shipment of machinery, tools and supplies to equip the new observatory shop which Professor Hussey is having built at La Plata. Dr. Sebastian Albrecht, formerly of the Lick Observatory, and more recently first astronomer of the Argentine National Observatory at Cordoba, has been appointed junior professor of astronomy in the University of Michigan. During Professor Hussey's absence the Detroit Observatory of the University of Michigan is in charge of Professor R. H. Curtiss, the assistant director.

Professor Henry Fairfield Osborn gave the address published in this issue of Science on behalf of the State Museum at the ceremonies in Albany connected with the dedication of the new museum quarters in the Education building on October 15. On the evening of that day a commemorative dinner was given by Director Clarke to Professor Osborn and to the past and present members of the State Geological Survey staff at which covers were laid for about forty guests. Among those present were Dr. Charles D. Walcott, Dr. George F. Kunz, Professor James F. Kemp, Professor H. P. Cushing, Professor H. S. Williams, Professor Charles Schuchert, Dr. H. S. Fairchild, Dr. E. O. Hovey, Dr. C. S. Prosser, Dr. E. O. Ulrich, Dr. E. M. Kindle, Dr. P. E. Raymond, Dr. C. R. Eastman, Dr. H. B. Kümmel, Dr. John C. Smock, Dr. J. B. Woodworth, Professor Gilbert Van Ingen, Dr. J. H. Stoller, Dr. C. P. Berkey, Professor H. P. Cleland, Professor C. E. Gordon, Professor A. W. Grabau, Dr. W. D. Matthew, Professor T. C. Hopkins and Professor W. J. Miller.

The scientific and operative staff of the Pennsylvania Chestnut Tree Blight Commission is now completed, and is as follows:

Pathologist—F. D. Heald, until recently professor of botany in the University of Texas.

Field Pathologist—Paul J. Anderson.

Entomologist—A. G. Ruggles, previously associate entomologist of the Minnesota State Experiment Station.

Forester in Charge of Utilization—J. P. Wentling, recently professor of sylvics in the Minnesota State School of Forestry.

Physiologist in Charge of Tree Medication—Caroline Rumbold, formerly of the Missouri Botanic Garden.

Geographer—F. P. Gulliver, formerly of the U. S. Geological Survey.

Tree Surgeon—Roy G. Pierce, formerly of the U. S. Forest Service.

Chemist—Jos. Shrawder.

Assistant Pathologists—W. H. Elza, R. D. Spencer, C. A. Gates, D. C. Babcock, J. F. Burrows and R. C. Walton.

Mr. Joseph C. Bock, formerly instructor in chemistry at Michigan Agricultural College, has been appointed chemist in the Nutrition Laboratory of the Carnegie Institution of Washington, Boston, Massachusetts.

Mr. James H. Gardner, formerly assistant geologist on the U. S. Geological Survey, who has recently been engaged in work on the clays, coals and oil fields for the State Geological Survey of Kentucky, has been engaged by the Topographic and Geologic Survey of Pennsylvania and given charge of the mapping and general study of the Broad Top Coalfield, with field headquarters at Hopewell, Pa.

Joseph F. Brewster, A.B. (Delaware, '98), Ph.D. (Berlin, '12), has been added to the staff of the chemical division of the North Carolina Agricultural Experiment Station at West Raleigh. He will assist in the investigation of the toxicity of cotton seed meal.

Waldemar T. Schaller, Ph.D. (Munich), mineralogist and chemist of the United States Geological Survey, has returned to duty after six months leave of absence. Most of the time was spent in Germany at the universities of Munich and Heidelberg, but nearly all the chief mineral collections of Europe were also visited and studied.

Professor Azariah S. Root, who returns to Oberlin College from a half-year leave of absence for study abroad, has completed some investigations in connection with the problems of early printing. Professor Root, who is professor of bibliography and college librarian, conducted special research work in the John Rylands Library, Manchester, England, the Bodleian, the British Museum, and the Bibliothèque Nationale in Paris, supplemented by later travel in Belgium and Holland to determine whether Johann Gutenberg of Mainz or Laurenz Coster of Haarlem was the originator of printing by movable types.

In the proceedings of the Minneapolis meeting of the American Association for the Advancement of Science, the death is announced of Charles Frederick Shaw, of State College, Pa., the name having been confused with that of Charles H. Shaw, of Ambler, Pa., who was drowned in Canada. Professor C. F. Shaw writes to the permanent secretary of the association: "I wish to say that to the best of my knowledge I did not die in 1911, nor have I been dead at any time since. At least my life insurance policy is still in force and I am carrying on the work that I have been doing during the past years. I have interviewed several of my co-workers, all of whom have assured me that I am still living and with this evidence I believe I can at least say with Mark Twain 'that the report is grossly exaggerated.'"

AT the annual meeting of the American Association for the Study and Prevention of Infant Mortality, held in Cleveland, the following officers were elected to serve for the ensuing year: *President,* Dr. L. Emmet Holt, of New York; *president-elect,* Dr. J. Whitridge Williams, of Baltimore; *first vice-president,* Dr. Isaac A. Abt, of Chicago; *second vice-president,* Dr. Arthur D. Baldwin, of Cleveland; *secretary,* Dr. Philip Van Ingen, of New York; *treasurer,* Dr. Austin McLanahan, of Baltimore; *executive secretary,* Miss Gertrude B. Knipp, of Baltimore. The next meeting of the association will be held in Kansas City, Missouri.

DR. C. P. STEINMETZ gives each year a lecture in Chicago before a joint meeting of the Chicago Section of the American Institute of Electrical Engineers and the Electrical Section of the Western Society of Engineers. The lecture this year will be on October 28 and the subject is "Some Problems in Electrical Engineering."

ON the evening of October 3 Professor H. E. Jordan, of the University of Virginia, delivered an address on "Eugenics: the Rearing of the Human Thoroughbred," before the American Association for the Study and Prevention of Infant Mortality, meeting in Cleveland.

THE Royal Geographical Society, London, proposes to hold on March 17 a meeting commemorative of the centenary of the birth of David Livingstone, when Sir Harry Johnston will give an address and there will be an exhibition of Livingstone relics. At a date not yet fixed Sir Clements Markham will give an address in commemoration of the discovery of the Pacific Ocean in 1513 by Balboa.

THE Rev. Dr. Walter W. Skeat, professor of Anglo-Saxon at Cambridge University, died on October 7 at the age of seventy-seven years.

THE state of Minnesota has engaged Dr. Ernest B. Hoag, a health expert, to travel about the state and demonstrate to the citizens that rational conservation of the mental and physical health of children is possible and practicable with the means already at hand. Three plans are proposed: (1) Organization with a medical officer and a nurse or nurses; (2) organization with a school nurse or nurses only; (3) organization by the employment of a simple non-medical health survey on the part of the teacher only. To make it possible for every community, however small, to possess the necessary technical knowledge, the state board of health will maintain at the state capital a "clearing house of information concerning child hygiene, medical supervision, the teaching of school hygiene and the like."

UNIVERSITY AND EDUCATIONAL NEWS

A HUNDRED thousand dollars to endow scholarships for young men has come to the University of California through the decree of final distribution for the estate of Mrs. Carrie M. Jones, of Los Angeles.

MOUNT HOLYOKE'S alumnæ committee reports that its efforts to raise a half million dollar fund for the college have met with success. The committee has turned over to President Woolley vouchers for $552,000. Of this amount $100,000 is to be devoted toward a $125,000 student-alumnæ building.

THE trustees of Columbia University announce that under the will of the late Augustus W. Openhym an endowment had been established for research work into the cause, prevention and cure of cancer. The amount of the gift was not made public, but it was said the sum was considerable. If at any time further research into cancer shall no longer be necessary, Mr. Openhym's will stipulates that the income may be used for research work in any branch of medicine or surgery. The endowment under Mr. Openhym's will is to be known as the Openhym Research Fund, and the terms of the gift are substantially the same as those of the Crocker Research Fund which amounts to $1,440,000. The authorities of Columbia University plan to combine the two endowments.

ON September 24 ground was broken, as we learn from the *Journal* of the American Medical Association, by Dr. Edgar F. Smith, provost of the University of Pennsylvania, and former Mayor Weaver, for the Thomas W. Evans Museum and Dental Institute, at Fortieth and Spruce Streets. The ceremonies were attended by the deans of the University of Pennsylvania, members of the faculty of the University Dental School, representatives of the various dental alumni associations and the French and English consuls. The building is expected to be completed in the fall of 1913 and, according to the plans, will be the largest and best equipped dental school in the world, supported by an endowment of $600,000. The building will cost about $500,000. The Museum and Dental Institute will be under the administration of the university. Dr. Evans, the famous Paris dentist in Louis Napoleon's reign, was a former Philadelphian who died in Paris in 1897.

In conjunction with the state department of health, the medical school of the University of Wisconsin has established a course extending over one year and leading to a diploma in public health. This course will be open only to those who have received a degree in medicine or a degree in medical or sanitary science. The full course for the present college year includes work in nine different fields and is intended to give a comprehensive survey of public health work. How certain diseases may be transferred from animals to man, and how to combat diseases resulting from employment at unhealthful occupations, are two of the things that will be studied. To show students the results of improper lighting and ventilation systems in factories and school houses, etc., special trips will be made by the class. Inspection trips to slaughter houses, meat markets, dairy barns and other places which may have a vital effect upon the health of a community will also be made.

The forty-first session of the College of Medicine of Syracuse University began October 1 with 31 students registered in the entering class and three entered with advanced standing. At the opening exercises Chancellor James R. Day spoke to the students and Professor Henry L. Elsner gave the opening address, "Traditions and Ideals." Dean Heffron announced the changes that had been made in courses and in instructors, most important of which were: The creation of an independent department of bacteriology, to the head of which Professor Leverett Dale Bristol, A.B. (Wesleyan), M.D. (Johns Hopkins), was called from Minneapolis. The election of Earl V. Sweet, A.B. (Colgate), M.D. (Cornell), as instructor in histology. The election of Mr. John R. Rice, B.S. (Wesleyan), to be instructor in the department of hygiene and preventive medicine and assistant in the Municipal Laboratory. The election of Albert G. Swift, M.D. (Syracuse), of New York City, to be instructor in clinical surgery. The election of John W. Cox, M.D. (Syracuse), as instructor in pathology. Dr. Frank P. Knowlton, professor of physiology, has returned from a year's leave of absence spent in the University of Cambridge and University College, London. A plan was inaugurated by which each student shall have control of a special microscope which he shall own at the end of his course. The contract for the new College Dispensary has been let and work has begun on the building.

Dr. Edward Thompson Fairchild, of Lawrence, Kans., superintendent of public instruction of that state and president this year of the National Education Association, has been elected president of the New Hampshire College.

The vacancy in the department of philosophy at De Pauw University caused by the resignation of Dr. William G. Seaman, who has been elected president of Dakota Wesleyan University, has been filled by the election of Frederick M. Harvey, Ph.D. (Boston, '11).

Glen Z. Brown, Ph.D. (Penna.), has been appointed professor in chemistry in Bucknell University.

At the University of Minnesota many new appointments have been made. Robert B. Gibson has been made assistant professor of physiologic chemistry; Walter E. Camp and

Elmer R. Hoskins, assistant demonstrators in anatomy. Alois F. Kovarik, of the department of physics, and Herbert H. Woodrow, of the department of philosophy and psychology, have been advanced to the rank of assistant professor. In the agricultural college numerous changes in titles and promotions include J. P. Wentling, from assistant to associate professor of forestry; A. R. Kohler, from instructor to assistant professor of horticulture; J. L. Mowry, from instructor to assistant professor of agricultural engineering; H. B. Roe, in mathematics, W. H. Frazier, in soils, W. L. Oswald, in agricultural botany, Rodney M. West, in agricultural chemistry, A. C. Arny, in agronomy, were all advanced from rank of instructor to assistant professor. A. M. Bull was advanced from instructor in engineering to engineer in charge of buildings with rank of assistant professor. In the college of medicine and surgery the following promotions and changes in title were made: W. P. Larson, bacteriology and pathology, H. P. Ritchie, surgery, F. L. Adair, obstetrics and gynecology, A. S. Hamilton, mental and nervous diseases, E. S. Strout, ophthalmology and otology, Henry L. Williams, gynecology, Wm. A. Hilton, histology and embryology, were all advanced to the rank of assistant professor from that of instructor.

DISCUSSION AND CORRESPONDENCE

GYROCOCCUS FLACCIDIFEX AND THE "FLACHERIE"

In Science, August 16, Mr. R. W. Glaser and Mr. J. W. Chapman report the discovery of the specific organism which causes "Flacherie" in the gypsy moth caterpillar, and have named it *Gyrococcus flaccidifex.* The communication which pays a handsome and well-deserved compliment to similar work done in Germany on closely related forms, has complacently pronounced "some of the attempts made in this country" to be unscientific. In this very generalized criticism direct reference is made to my paper of 1911.[1] Since a number of statements and their general tone are misleading, a brief correction is not out of place.

In my paper of 1911, the following contentions were made:

1. That the epidemic flacherie can be induced by special methods in feeding healthy gypsy moth caterpillars.

2. That, having obtained material thus diseased, it is possible to spread the epidemic flacherie by hanging bags of this dry, dead material in healthy caterpillar colonies.

3. That by obtaining diseased material early and hanging it soon after the caterpillars have hatched in the field we have a very efficient means of preventing serious damage, because the disease destroys the greater number of larvæ at early stages.

The authors in their study of the flacherie decide that:

1. This work is unscientific.

2. That it seems very improbable that any such methods as are at present utilized for the artificial spread of flacherie will be of any avail.

It is hardly conceivable that two entomologists should insist that another entomologist must work on the bacteriological side of this problem in order to be scientific. Competent bacteriologists, such as Dr. H. N. Jones, working under the direction of Dr. Theobald Smith, of the Harvard Medical School, have already attacked the bacteriological side of this problem, and report negative results in seeking the specific organism.[2] Of course, it is possible that an organism which can be seen with simple staining methods or with no stains at all might have been overlooked by the bacteriologists. The authors admit that *Gyrococcus flaccidifex* can be obtained in great numbers. When a healthy caterpillar is inoculated with a pure culture of *Gyrococcus* and dies in a limp or flaccid state, how can any one be sure that this is the same as

[1] Reiff, William, "The Wilt Disease, or Flacherie, of the Gypsy Moth. How to aid the Spread of this Disease." Boston, 1911. Wright & Potter Printing Company.

[2] Jones, Dr. J. N., "Further Studies on the Nature of the Wilt Disease of the Gypsy Moth Larvæ," in *The State Forester of Massachusetts*, Seventh Annual Report, 1910.

death from the organism which causes the epidemic flacherie? There are undoubtedly many organisms which might cause the death of a caterpillar and a subsequent limp condition.

I do not wish to dictate or discuss what makes a piece of work scientific or unscientific, for that is out of my sphere; but I have previously stated my own incompetency to work on bacteriology in relation to the problem of the epidemic flacherie.[3]

The authors state that they have no experimental evidence that the disease may be airborne but do not wish to exclude such a possibility. Bolle,[4] Prowazek[5] and Wahl[6] have used methods involving dry infection, working on the flacherie of either the silk worm, or nun moth or both. All of these investigators have also used dry cultures at least a year old with positive results. This would give some reason to believe that dry infection may be possible in the flacherie of the gypsy moth. Wahl used methods in combating the nun moth, showing that the disease was air-borne. Glaser's and Chapman's experiments as given in their table deal only with wet infection and no inferences involving the various phases of dry infection can be legitimately drawn. From my own paper of 1911 and later work, as yet unpublished, it is apparently evident that the epidemic flacherie (very possibly different from the disease which Glaser and Chapman induced) is also air-borne. In this disease it is entirely unnecessary to feed the caterpillars with my culture or inoculate individuals with large numbers of *Gyrococcus flaccidifex* or some organism that is unknown in order to produce an epidemic of flacherie and death. Whatever the organism may be which causes epidemic flacherie, it is certainly spread with ease and kills young larvæ after the first instar, no matter what the weather or food conditions may be. Glaser and Chapman have not considered secondary hosts, other stages of their bacteria or virulent strains.

Unfortunately the term "flacherie" is very indefinite, but it has long been suspected that a number of different diseases are included in this term. That disease which expresses itself as an epidemic of flacherie may be due to one or a number of organisms or stages of organisms. More work by the bacteriologists will be heartily welcomed.

William Reiff

Forest Hills, Mass.

[3] Reiff, William, "Some Experiments on Flacherie in the Gypsy Moth," *Psyche*, Vol. XVI., No. 5, Boston, 1909.

[4] Bolle, J., "Vorläufige Mitteilungen über die Gelbsucht der Seidenraupe," *Atti e Memoire dell' i. r. Società agraria*, Görz, 1894.

[5] Prowazek, Dr. S., "Chlamydozoa," *Archiv für Protistenkunde*, 10. Band, Jena, 1907.

[6] Wahl, Dr. Bruno, "Uber die Polyederkrankheit der Nonne (*Lymantria monacha* L.)," *Centralblatt für das gesamte Forstwesen*, Heft 6, Wien, 1911.

A NEW FLY TRAP

To the Editor of Science: In these days of general campaigning against the house fly, it may be of passing interest to the readers of Science to know that we have constructed at this station a fly trap which catches flies in such wholesale numbers that its merits are apparent to any one. So successful have we been that we have ventured to call it "The Minnesota Fly Trap."

The trap is twenty-four inches long, twelve inches high and eighteen inches across, the material consisting of a very little lumber and wire mosquito screen, costing 41 cents. A good carpenter can make one in one to three hours.

The director of this station felt the need of locating on the campus some fly traps which would capture flies in large numbers and as a result of his expressing the desire, this trap was constructed.

We find bread and milk (if more attractive food is not exposed) frequently renewed, to form the best bait. The following record shows how useful this contrivance is. In one day in the dairy barn, it caught 1,700 flies; rear of dining hall, two days, 3,000 flies; same place, five days, 13,000 flies; same place, one day, 4,200 flies; on the back porch of a dwelling house not far from a stable containing a few horses, one day, 12,000; same place, one and a half days, 18,800 flies.

The writer would be very glad to mail illustrated leaflet describing this trap to any one desiring the same.

F. L. Washburn
Minnesota Experiment Station,
St. Anthony Park, Minn.,
August 19, 1912

SCIENTIFIC BOOKS

Technical Methods of Chemical Analysis. Edited by George Lunge, Ph.D., Dr. Ing., Emeritus Professor of Technical Chemistry, Federal Polytechnic School, Zürich. English Translation from the latest German Edition, adapted to English conditions of manufacture. Edited by Charles Alexander Keane, D.Sc., Ph.D., Principal and Head of the Chemistry Department, The Sir John Cass Technical Institute, London. Volume II., 2 parts, pp. xxvii + 1,252. New York, D. Van Nostrand Company. 1911. Price $18.00 net.

The Manufacture of Sulphuric Acid and Alkali with the Collateral Branches. A Theoretical and Practical Treatise. By George Lunge, Ph.D. Third Edition. Volume III., Ammonia-Soda, Various Processes of Alkali Making and the Chlorin Industry, pp. xix + 764. New York, D. Van Nostrand Company. 1911. Price $10.00 net.

It is gratifying to know that such substantial progress has been made on the English translation of these two standard and almost indispensable works, and that only one volume of each remains to be published. It is indeed unfortunate that English translations should be needed, but the fact can not be ignored that a large proportion of our technical men do not read German, and that no work is really accessible to them unless it is printed in English. Even the younger generation, who have been compelled in their technical school training to use both German and French, seem in a great hurry to drop their knowledge of these languages as soon as they get out at work.

One general criticism may be passed on both of these books. They have been prepared and edited largely from an English standpoint, and American practise has been to far too great an extent ignored. There has been great development in recent years, both along the line of rapid methods of technical analysis and also in standardizing analytical methods, and along both these lines American chemists have been by no means backward, yet under Iron and Steel there are but 19 footnote references to American literature against more than 100 to English and more than 130 to German sources, and under Illuminating Gas and Ammonia but five out of 140 references are to American publications or apparatus. We also note that under Copper no reference is made to the use of a platinum gauze kathode in electrolytic deposition, nor under Lead to Low's modification of Alexander's method in the presence of calcium. It would have given a broader value to the first book had it not been quite so exclusively "adapted to English methods of manufacture."

Aside from this criticism the reviewer has nothing but favorable comment for both these books. In this second volume of Technical Methods, the following subjects are treated: Iron, by Dr. P. Aulich; Metals other than Iron, and Metallic Salts, by Professor O. Pufahl; Artificial Manures, by Professor O. Böttcher; Feeding Stuffs, by Dr. F. Barnstein; Explosives, by Oscar Guttmann; Matches and Fireworks, by Dr. A. Bujard; Calcium Carbide and Acetylene, by Professor Lunge himself and Dr. E. Berl; Illuminating Gas and Ammonia, by Dr. O. Pfeiffer; Coal Tar, by Dr. H. Köhler, and Organic Dyes, by Professor R. Gnehm. These comprise the subjects included in the second and third volumes of the new German edition, together with the section on Organic Dyes from the fourth and last volume. Under each head are given quite fully the standard methods of analysis of all the products connected with the industry, and at least an outline of other methods which promise to be improvements. In each case references are given to the original sources. The book is brought well down to date, and is conspicuous by the absence of descriptions of antiquated methods which have only a historical interest. Covering, as it does with the other volumes, the whole field of the analytical chemistry of technical products, the book is indispensable to the library of every analytical chemist.

The other book under review has since the publication of its first edition been recognized as the standard work on the manufacture of sulfuric acid and alkali. This third volume was in earlier editions the concluding volume, but, so great has been the development of electrolytic methods of manufacture in recent years, it has been found necessary to add a fourth volume, which is shortly to appear, and which is to include the electrolytic manufacture of alkali and chlorin. This will be prepared by Professor Askenasy and Professor Haber, recognized authorities on the subject. The work of Dr. Lunge is concluded with this third volume, which is devoted to the ammonia-soda process, processes for the manufacture of soda other than the LeBlanc and the ammonia-soda, and to the manufacture and utilization of chlorin. This last section includes bleaching powder and other bleaching liquors and compounds, and the chlorates.

It is rather striking that in as important industry as the manufacture of soda, the methods all but exclusively used throughout the nineteenth century were the LeBlanc, first put in operation before the century opened, and the ammonia process, suggested at least early in the century. Further, while the mechanical details, of course, were greatly improved, there was practically no change in the chemical principles involved. Curiously the first suggestion of the ammonia process seems to have come from Fresnel in 1811, but "the invention soon sank into oblivion, and Fresnel himself, whose thoughts were later fully occupied by his magnificent reforms in the domain of optics, did not give any more time to it." John Thom, a chemist in the factory of Turnbull and Ramsay in Scotland, actually worked the process, including the ammonia recovery in 1836, but it was later abandoned, though his other practise of utilizing the ammonia residues as manure won for Thom the merit of founding the industry of artificial fertilizers. In 1838 the first patents on the process were taken out by Dyar and Hemming, and various manufacturers experimented with it, but in the hands of none did it prove a commercial competitor with the LeBlanc. The mechanical difficulties were great, and then, owing to the recovery of the chlorin by-products, the LeBlanc process has always been able to compete with the ammonia method. It was not till 1861 that the Belgian Solvay began independently the development of the ammonia process, now perhaps more commonly known as the Solvay process, and soon placed it on a commercial basis. Since that time the output has steadily increased, passing that of the LeBlanc process about 1888, and from that time the production by the latter process has constantly declined. In this country the LeBlanc process has never been worked, while the ammonia process has had considerable development. Both these processes are now threatened, especially in this country, by the recent rapid development of electrolytic processes, which will in the near future probably drive the LeBlanc process to the wall.

The hundred or so pages of the book devoted to the description of "other processes" is interesting reading, but somewhat painful, representing as it does so many futile hopes. Not less than a hundred different methods, most of them represented by sometimes several patents, are referred to, and not one of them (excepting the cryolite process) is of appreciable commercial value at present. The same may be said of most of the suggested processes of chlorin manufacture, for it is hardly a rash prediction that these will all soon give way to the electrolytic manufacture. In the statistical tables at the end of the book we note that in 1904 half of the chlorin products the world over were from electrolytic chlorin, and that only in Great Britain and France was LeBlanc chlorin predominant. We also note that in 1895 the United States produced 166,562 tons of alkali, less than was imported, while in 1900 the production was 539,541 tons and in 1905, 734,209 tons. In the last two periods the importation of bleaching-powder into the United States had decreased from 136,403 tons to 96,110 tons. Unfortunately this statistical portion is the only part of the book not brought well down to date.

J. L. H.

The Elements of Statistical Method. By WILLFORD I. KING, M.A. New York, The Macmillan Company. 1912. Pp. xvi + 250.

It is "the purpose of this book to furnish a simple text in statistical method for the benefit of those students, economists, administrative officials, writers, or other members of the educated public who desire a general knowledge of the more elementary processes involved in the scientific study, analysis and use of large masses of numerical data."

With this purpose in mind, the author presents only the most simple of the mathematical theorems on which the statistical method is based. The book is arranged so as to treat the subject in four main parts: (1) The historical development and general characteristics of statistics; (2) the gathering of material; (3) analysis of material collected; (4) comparison of variables. The great variety of topics dealt with under these general headings indicates the breadth of view desirable for an adequate treatment of statistical problems, and suggests the many pitfalls that endanger the certainty of conclusions drawn from some kinds of statistical data. The book is to be commended for the clearness with which it brings a large number of topics concerning statistics to the attention of the educated public. This is surely a matter of the highest importance.

It seems desirable to criticize the treatment of the notion of "the probable error." On p. 78, we find the following statement: "If $E =$ the possible error of the arithmetical average, the probable error of the same is approximately $E/\sqrt{n}$." For proof, we are referred to Bowley, "Elements of Statistics," pp. 303–315. I fail to find that Bowley attempts to obtain a relation between probable and possible errors. He does show, within the limits of this reference, that the probable error of the arithmetic mean of n variates is $E/\sqrt{n}$, where E is the probable error of a single variate. It seems to the reviewer that the book is not clear on the notion of a probable error, and even presents an incorrect conception of this subject. On pp. 213–214, the statement is made that the probable error of a coefficient of correlation varies inversely both with the number of pairs of items and with the size of the coefficient. Then the well known formula

$$\frac{0.67(1-r^2)}{\sqrt{u}}$$

is given for this probable error. It is therefore obvious that the author does not use the expression "varies inversely" in its usual meaning in mathematical sciences. Later, on p. 214, is the statement that the probable error indicates that the chances are that r actually lies between

$$r + \frac{0.67(1-r^2)}{\sqrt{n}} \quad \text{and} \quad r + \frac{0.67(1-r^2)}{\sqrt{n}}.$$

This statement is obvious but useless when taken in one sense. It tends to give an incorrect conception of the meaning of a probable error, when taken in another and important sense.

To summarize, it seems to the reviewer that the strength and usefulness of the book lies in its popular presentation of some of the leading ideas of the best statistical method of the present day. The weakness of the book lies in its presentation of a vague and even incorrect conception of the meaning of the probable error of a statistical result.

H. L. RIETZ

UNIVERSITY OF ILLINOIS

POPULAR AND TECHNICAL BOOKS ON HEREDITY

Einführung in die Vererbungswissenschaft. By RICHARD GOLDSCHMIDT. Leipzig, Wilhelm Engelmann. 1911. Pp. x + 502. Price, 12.25 M., paper, 11 M.

This book is one of several from German authors that have been welcomed by American students because of the want of a suitable text in our own language. In twenty chapters the author treats of variation and statistical methods, with their present and former application, mutations and fluctuations, inheritance of acquired characters, Mendelism, mechanism of heredity, graft hybrids, and sex-determination.

Statistical methods are discussed briefly, not as in a text-book of statistics and their manipulation, but merely to point out the kind of problem amenable to attack in this way. The author is, however, cautious in advocating statistical methods, pointing out as others, particularly Johannsen, have done, that mathematics without biological analysis is valueless. At the close of the discussion of biometrics, Galton's laws of regression and of ancestral contributions are briefly reviewed, but the view is advocated that these laws are no longer of biological value. In the conclusions drawn from the study of pure lines, the author is in substantial accord with Johannsen.

Mutations are regarded as probably not essentially different from fluctuations, the latter being capable, under certain circumstances, of becoming the former. This conclusion is based largely on the work of Tower. The question of mutations then becomes, What fluctuations may become heritable, and under what circumstances?

Prefatory to a discussion of acquired characters, much evidence is adduced to show a connection between somatic and germ cells. In this evidence is included the effects of gonad extracts upon somatic characters, though one may wonder what bearing this has upon somatic influence on germ cells. One misses the negative results obtained by Smith from injections in fowls, but the book was probably written too early to include this. Guthrie's transplantation experiments are accepted at par, though there seems good reason to doubt their validity.

The inheritance of acquired characters is believed, on the strength of the newer evidence, to be probable. Goldschmidt is the more ready to adopt this view because he regards mutations as only special forms of fluctuation. The theory of parallel induction (the simultaneous action of the environment on both soma and germ cells so as to produce identical variations in parent and offspring), which was supported by Tower's experiments on *Leptinotarsa*, meets, in the author's opinion, an insurmountable difficulty; but how simple induction (the effect of an already modified soma on the germ cells so as to produce the same modification in the offspring) encounters any less insurmountable difficulties, is not explained. They seem to the reviewer to be equally inconceivable.

The half dozen chapters on Mendelism constitute a treatise, for the most part elementary, in which are discussed the various cases of mono-, di- and poly-hybrids. Doubt is expressed as to whether species hybrids exhibit Mendelian behavior, on the ground that equality of reciprocal crosses is a rule of Mendelism, whereas in many species crosses the reciprocal crosses are distinctly unequal. The reviewer finds cases where reciprocal varietal crosses are also unequal. To explain intermediate F_1 the author accepts as probable the assumption that many genes combine to produce a single visible character.

The Sutton-Boveri hypothesis of the segregation of genes is rejected on the ground that there are cases in which there are more independently heritable characters than there are chromosomes, notwithstanding the fact that the existence of such cases has not been demonstrated to the satisfaction of all geneticists. In its place the author adopts a theory of end-to-end union of the chromosomes (telosynapsis) in such a way that either maturation division may be a reduction division, whereby the number of possible combinations is greatly increased. The individuality of the chromosomes is not maintained in this theory.

The chapters on sex-determination are perhaps one of the least satisfying parts of the book. This is partly owing to the unsettled condition of the subject. One could wish, however, for a fuller analysis of the more important current theories. According to the author, secondary sexual characters afford no evidence fitted to solve the problems of sex. The evidence of Mendelian inheritance of sex is strongest in sex-limited inheritance; but even here a non-Mendelian hypothesis is held to be better. Sex-determination is a phenomenon of cell physiology and cell regulation. "To say more would certainly be premature."

Several minor criticisms might be made. Typographical errors are infrequent. "Biotype" is made synonymous with "pure line" on page 122. One feels that the inheritance of acquired characters could be discussed more judicially after Mendelism, instead of before it. On the whole, however, the book is very well written and well made, and will be a valuable aid to both teachers and students.

The Heredity of Richard Roe. By David Starr Jordan. Boston, American Unitarian Association. 1911. Pp. 165. Price, $1.20.

Heredity in the Light of Recent Research. By L. Doncaster. Cambridge, The University Press. 1911. Pp. 143. Price, 40 cents.

These two books are intended for the laity, and are excellently designed for their purpose. Richard Roe is a typical man, whose history is described from germ cell to manhood. The author's treatment of his hero is conditioned by his public, and is popular to a degree not usually combined with accuracy. Because the book will be read by the uninitiated, one feels that the case against prenatal influences, for example, could have been made stronger without compromising the author's scientific standing. There is considerable matter in the latter part of the volume that seems at first sight irrelevant to the heredity of Richard Roe. But the whole book is written in such delightful style, a style which those acquainted with the author will at once recognize, that differences of opinion regarding emphasis or relevance are quickly forgotten.

If Jordan's book furnishes inspiration, Doncaster's supplies information. The latter volume gives, in small compass, the main facts of heredity in a form readily grasped by any intelligent reader, yet with all the accuracy which the author's scientific reputation leads one to expect. Heredity is approached by the usual road, with a discussion of variation, its causes, and its study by statistical methods. The reader is given an elementary understanding of Mendelism, and is led within sight of some of the disputed questions regarding purity of gametes, inheritance of acquired characters, etc. Heredity in man, with its sociological bearing, closes the main part of the volume. Two appendices treat of the history of theories of heredity and the material basis of heredity. There is a short glossary, and a bibliography in which those books suitable for general readers are specially designated.

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A CLASSIFICATION OF THE DEPARTMENTS OF BOTANY AND AN ARRANGEMENT OF MATERIAL BASED THEREON

No one has made a serious attempt at the classification of the departments of botany. Various short classifications have been given in text-books with a view to arranging the facts presented to botanic students, but I am not aware that these have been made with a thought at presenting in logical sequence the divisions into which botany naturally may be divided. Such an arrangement is an important matter when the botanist wishes to arrange his books, photographs, microscopic and lantern slides, as well as museum material of plants. Recognizing the lack of such information, the attempt is made here to give a logical classification of the departments of botany, and it is hoped that the readers of Science will make additions and corrections, or suggest a rearrangement of this preliminary and tentative scheme, which is presented in outline without definitions, which may be found in any large dictionary of the English language.

DEPARTMENTS OF BOTANY

I. *Systematic Botany.*
- Terminology.
- Nomenclature.
- Classification.
- Taxonomy.
- Phylogeny.

II. *Morphologic Botany.*
- Organography, including Morphogenesis.
- Biometry.
- Experimental Morphology.
- Teratology.
- Histology.
- Cytology.
- Embryology.

III. *Physiologic Botany.*
- Special Physiology.
- Phenology.
- Zymology.
- Genetics
  - Inheritance.
  - Hybridization.
  - Plant Breeding.

IV. *Ecologic Botany.*
- Ecology Proper.
- Anthobiology.
- Myrmecophily.
- Cecidology.

V. *Geographic Botany.*
- Distribution.
- Distributional Philosophy.
- Distributional Statistics.
- Floristics.
- Synecology.

VI. *Pathologic Botany.*
- Pathography.
- Etiology
  - Physiologic Pathology.
  - Toxicologic Pathology.
  - Bacteriologic Pathology.
  - Fungologic Pathology.
  - Entomologic Pathology.
  - Chemic Pathology.
- Therapy.
- Prophylaxis.

VII. *Paleontologic Botany* (*Paleobotany, Paleophytology*).
- Paleography.
- Paleostratigraphy.
- Paleogenesis.
- Paleotechnics (Paleomechanics).

VIII. *Historic Botany.*
- Etymology.
- Biography.
- Synonymy.
- Bibliography.
- History of Botanic Work, Exploration and Discovery.

IX. *Philosophic Botany.*

X. *Ethnobotany.*

XI. *Applied Botany.*
- Cultural.
- Agricultural.
- Horticultural
  - Floriculture.
  - Fruticulture.
  - Olericulture.
  - Viticulture.
- Forestal.
- Landscape Gardening.
- Esthetic (use of plants in decoration).
- Economic.
- Medical
  - Pharmacognosy
    - Pharmacoërgasy (culture, collection and harvesting of drugs).
    - Pharmacoemporia (commercial handling of drugs).
    - Pharmacodiakosmy (packing, etc.).
  - Pharmacology.
  - Pharmacodynamics.
  - Phytotoxicology.
  - Materia Medica.
- Educational.

The application of this scheme of classification is illustrated in the arrangement of a collection of lantern slides, according to the following:

CLASSIFICATION OF LANTERN SLIDES

SYSTEMATIC.—Arrangement according to Natural Families (see Engler's "Syllabus der Pflanzenfamilien," 1–314).

MORPHOLOGY (Spermatophytes).—The general and detailed structure of Angiospermæ and Gymnospermæ.

315. Seedlings.
316. Roots.
317. Stems and Buds.
318. Leaves.
319. Flowers.
320. Stamens and Pollen.
321. Pistil, including Ovary, Style and Stigma.

322. Fruits and Seeds.
323. Distribution of Fruits and Seeds.

Histology (Pteridophyta).—Minute microscopic anatomy. See systematic slides for other details and embryology for details of development, etc.

324. Anatomy of Root.
325. Anatomy of Stem.
326. Anatomy of Leaves.
327. Anatomy of Other Parts.

(Gymnospermæ). Microscopic Anatomy. See embryology for details of fertilization and embryonic development.

328. Anatomy of Root.
329. Anatomy of Stem.
330. Anatomy of Leaves.
331. Anatomy of Other Parts.

(Angiospermæ).

332. Cells in General.
333. Cytoplasm.
334. Nucleus and Division. The slides are arranged alphabetically according to the author's name.
335. Cell Contents. Plastids; Starch; Aleurone Grains; Inulin; Crystals and Cell Sap.
336. Cuticle and Epidermis (Hairs, Glands and Pitchered Leaf Surfaces).
337. Tissue and Tissue Differentiation.
338. Organs of Secretion and Milk Tubes.
339. Anatomy of Roots.
340. Anatomy of Stems.
341. Anatomy of Leaves.
342. Stomata.

Embryology. Fertilization, development of embryo. Fertilization in lower plants (algæ, fungi, mosses) given with systematic slides.

343. Pteridophyta.
344. Gymnospermæ.
345. Angiospermæ.

Physiology.

346. Apparatus and Materials.
347. The Structure and Properties of Protoplasm (see histology under the head of Cytoplasm).
348. Nutrition of Plants.
    (*a*) Absorption of Water and Dissolved Minerals.
    (*b*) Transfer of Water and Minerals.
    (*c*) Transfer of Elaborated Substances.
    (*d*) Absorption of Gases.
349. Transpiration and Apparatus.
350. Metabolism. Phytosynthesis; Respiration; Fermentation; Nitrogen Assimilation; Use of Minerals; Formation of Special Substances; Storage; Secretion; Excretion (see slides under histology).
351. Growth; Increase in Size; Measurements; Effect of External Conditions; Movements.
352. Reproduction (see slides classified systematically under algæ, fungi, mosses and embryologic slides under embryology).
353. Genetics. Hybrids and New Races produced by Plant Breeding.
354. Irritability. Geotropism; Heliotropism; Hydrotropism; Thigmotropism; other tropisms and manifestations of irritability.
355. Locomotion.

Ecology. For some slides illustrating relationship of flowers, insects, etc., see morphology. For slides illustrating some xerophytes, hydrophytes, mesophytes, see systematic slides and histology for microscopic structure. For distribution of seeds and fruits, see morphology.

356. Parasitism (see morphology).
357. Mycorhiza, Mycodomatia and Leguminous Tubercles. See Physiology under Nitrogen Assimilation.
358. Commensalism.
359. Cecidology (Galls).
360. Honey Dew and Plant Lice.
361. Fungi and Ants. (Extra-floral Nectaries.)
362. Pollination of Flowers.

Geography.

363. Maps illustrating Distribution of Species.
364. Statistic Charts of Distribution.
365. Photographs of Plant Formations; Associations and Societies. General Views of Plants under various Environmental Surroundings.

Pathology.

366. Diseases of Plants due to Insects. (For galls see Cecidology under Ecology.)
367. Diseases due to Fungi. Diseases of field and greenhouse plants; destruction of wood and timber; methods of study; inoculation; culture of diseased, as contrasted with healthy plants; laboratory methods; instruments; culture growths.
368. Diseases due to Climate.
369. Diseases due to Chemics (Gases, etc.).
370. Diseases that are purely Physiologic.

Paleobotany. For plants see under head of systematic slides.

371. Slides illustrating various fossil plants.

372. Instruments used in preparation of fossils for microscopic study.
373. Slides illustrating ancient vegetation in landscape reproductions.

Historic Botany.

374. Photographs of Noted Botanists.
375. Reproductions of Ancient Botanic Books.
376. Maps illustrating Routes of Botanic Travel.

Ethnobotany.

377. Cultural and Medicinal Plants of Indians.
378. Views illustrating Aboriginal Uses.

Applied Botany.

(*Cultural.*)

379. Variations.
380. Mutation (Sports).
381. Selection.
382. Propagation. Methods of Crossing illustrated; hybrids and hybridization; cuttings; grafting; methods of seed planting and care of seedlings.
383. Implements used in Agriculture and Horticulture.

Agriculture.

384. Preparation of Soils.
385. Application of Fertilizers (Visible Results of Application).
386. Cultivation of Crops.
387. Harvesting of Crops.
388. Preparation of Crops for Use.

Horticulture.

389. Greenhouse and Greenhouse Construction.
390. Culture of Greenhouse Plants.
391. Floriculture.
392. Fruticulture.
393. Olericulture.
394. Viticulture.

Forestal.

395. Preparation of Seed Bed.
396. Care of Young Trees.
397. Methods of Thinning.
398. Character of Forest (Pure, Mixed).
399. Relation of Trees to Soil, Light, etc.
400. Methods of Cutting.
401. Methods of Lumbering.
402. Sawing and Dressing.
403. Tools used in Forestal Operations.
404. Gathering of Secondary Products. Faggots, Turpentine, Sugar, Fruits and Seeds.
405. Trees in General.
406. Botanic Landscapes.

Landscape Gardening.

407. Japanese Gardens.
408. Italian and French Gardens.
409. Formal Gardens.
410. Natural Gardens.
411. Garden Plans, etc.

Esthetic Botany.

412. Plants and Flowers in Decoration.
413. Conventionalized Plant Parts for Wall-papers and Tapestries.
414. Artificial Flowers, etc.

Economic Botany. For figures of economic plants and their parts, see under systematic classification.

415. Food Plants in General.
416. Root Foods.
417. Stem Foods.
418. Leaf Foods.
419. Fruit Foods.
420. Farinaceous Products (see under histology, No. 335).
421. Spices.
422. Plants used in Textile Industries.
423. Tanning Plants.
424. Dye Plants.
425. Rubber Plants.
426. Gum-yielding Plants.
427. Oil-yielding Plants.
428. Building and Furniture.
429. Methods of Gathering.
430. Methods of Shipment.
431. Methods of Preparation.
432. Methods of Manufacture.
433. Machinery.
434. Packing for Sale.
435. Methods used in Sale and Distribution.

Medical Botany. For illustrations of medical plants see systematically arranged slides.

436. Culture of Drugs.
437. Collection and Harvesting.
438. Handling of Drugs.
439. Packing of Drugs.
440. Manufacture into Medicines.

Educational Botany.

441. Photographs of Home and Foreign Botanic Gardens.
442. Laboratory Buildings.
443. Laboratory Equipment.
444. School Gardens.
445. Students at Work.

The slides are all numbered according to the plan outlined above, and if more than one slide is to be classified with a given number, an additional number is added according to the decimal system of card indexing. Thus 442.1, 442.2, 442.3, etc., would indicate that there are several lantern slides illustrating the laboratory buildings of the world. The system of classification is thus made elastic.

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THE NEW CATALOGUE OF CHIROPTERA IN THE BRITISH MUSEUM

During the past twenty-five years the study of recent mammals has been pursued with an activity unprecedented in the history of other groups of vertebrates. Collections aggregating hundreds of thousands of specimens have been brought together, mostly by three or four museums, and the number of known forms whose existence was previously unsuspected has increased so rapidly that only a few specialists are fully aware of what has been taking place.[1] The trustees of the British Museum have recently issued the first volume of a second edition of the Catalogue of Chiroptera.[2] This is the first monographic treatment of a large group of mammals in which the systematic activities just alluded to are adequately summarized. Its interest is therefore twofold: to systematists an account of the technical matter which it contains, and to general zoologists as the first definite indication of the extent to which currently accepted ideas regarding the world's mammal fauna must be revised.

The volume now issued, containing more than 900 pages, is by Mr. Knud Andersen, who has spent nearly seven years in its preparation. It deals with the Megachiroptera, the old world fruit-bats, only. No group of mammals has ever been treated in such detail, and it is doubtful whether any work of similar size on any group of vertebrates contains so large and so well arranged a mass of original observations. The number of forms recognized is 228, distributed among 38 genera and subgenera. These are represented in the British Museum by 1,470 specimens and all but 21 of the species and subspecies.[3] In the first edition of the catalogue (Dobson, 1878) the Megachiroptera occupy 98 pages, with 78 forms and 13 genera and subgenera, represented by 425 specimens. This increase of nearly 300 per cent. is probably less than may be expected among the "insectivorous" bats (Microchiroptera). Mr. Andersen's studies of the Microchiropterine genus *Rhinolophus* resulted in an increase of from 21 to 105 or more, while his "Monograph of the Chiropteran Genera *Uroderma, Enchisthenes* and *Artibeus*," shows the old genus *Artibeus* with its six forms, as understood by Dobson, to consist of 32 forms representing three distinct genera. The number of bats known to Dobson was about 440; it is to be expected that the number recorded in the new edition of the catalogue will exceed 2,000. The significance of this increase will be understood when it is recalled that the entire number of living mammals is generally supposed to be about 5,000, a total in which the bats form about one tenth.

In general plan the present volume agrees with the original edition and with the well-known form of the British Museum "Catalogues." With the increase of fineness in discrimination, however, greater detail of treatment has become necessary. To take an example at random: in the original edition the account of *Pteropus "medius"* occupies two pages; in Mr. Andersen's volume it covers seven and a half without counting two devoted to a race not recognized by Dobson. This increase is due chiefly to the more elaborate description of characters, but it is partly the result of greater detail in the bibliographic citations: for the period covered by three lines under the name *medius* by Dobson 25 lines are here required. Perhaps the most striking

[1] The field work which has led to this result was made possible by the invention of several types of small traps, not originally intended for scientific purposes.

[2] "Catalogue of the Chiroptera in the Collection of the British Museum," second edition, by Knud Andersen. Vol. I., Megachiroptera. London, printed by order of the trustees, etc., 1912. Actual date of publication, March 23, 1912.

[3] About 1,000 specimens in other museums were also examined. All of this outside material is carefully designated in the text or in footnotes.

special feature of the purely technical part of this work as compared with its predecessor is the different degree of importance accorded to cranial characters. For Dobson the skull scarcely existed. Thirty years ago "there were separate skulls of only half the number of species of Megachiroptera then in the collection, whereas now every species and subspecies in the museum, with one exception (*Pteropus aruensis*) is represented by at least one and often by a series of skulls." The original edition contains figures of the skulls of 17 species, of which only one is a fruit-bat. In the present volume the skulls of 47 species are figured,[4] and detailed cranial and dental measurements are given of practically every recognized form.[5]

Another aspect in which Mr. Andersen's work differs from Dobson's is the relatively greater space allotted to speculation on such general subjects as distribution, interrelationships, the relative primitiveness or specialization of species, and the meaning of structures. The interest of the volume is thus much increased, particularly because it is here that the greatest individual differences of opinion are likely to be encountered. It is easy, for instance, to follow the author in his generic, specific and subspecific "splitting" of the *Cynopterus* group; but when he remarks of *Sphærias* (p. 673) that: "It must use its incisors in a way different from that of its relatives, as clearly shown by their remarkably proclivous position and peculiarly modified shape," he appears to offer a greater unknown quantity to explain a less. That is, until some member of this group is known to feed on other substances than fruit pulp there is no reason to believe that the exact form of the small and mechanically unimportant incisor teeth is of consequence to the animals. Such teeth in any mammal appear to assume any form readily developed from a generalized type; and that special modes of use enter into the problem has not yet been shown, however currently it may be assumed.

From the point of view of the general reader the discussion of geographic distribution (pp. lxxv–xcii) is of unusual interest. Mr. Andersen here shows the fallacy of the popular idea that bats, having wings, roam where they will, and of the more pernicious notion that philosophizing is profitable without exact and detailed knowledge of facts.[6] He says (pp. lxxvi–lxxviii):

> The evidence afforded by the geographical distribution of bats has generally been considered of doubtful value. . . . This unwillingness or hesitation to place bats on an equal zoogeographical footing with non-flying mammalia would seem to be due, partly to the preconceived idea that owing to their power of flight bats must evidently have been able easily to spread across barriers which, in ordinary circumstances, are insuperable for wingless mammalia; partly to the fact that hitherto very often whole series of distinct forms have been concealed under one technical name. So long as (to mention only three cases among many) *Macroglossus minimus* was believed to range unchanged from the Himalayas to New Guinea, Australia, and the Solomon Islands (now two distinct genera, thirteen recognizable forms), or "*Cynopterus marginatus*" over India, Ceylon, Indo-China and Indo-Malaya (now six species, fourteen forms), or "*Rhinolophus ferrum-equinum*" uniformly over Europe, Asia and Africa (now numerous distinct forms) they were undoubtedly of questionable value as zoogeographical material. But these and similar anomalies invariably disappear as soon as modern methods of discrimination applied on vastly increased material render it possible to draw the lines of separation between the species (and their local modifications) somewhat more closely in accordance with the lines drawn by nature. The second argument referred to above, that the spreading of bats from one locality to

[4] With two exceptions the 85 illustrations are original pen drawings by Mr. A. J. Engel Terzi. Their quality leaves nothing to be desired.

[5] The fact that the tables of measurements contain maxima and minima only is one of the few details of plan open to adverse criticism. The main object of making a series of measurements of the same part in a number of individuals is to discover what is normal; we are here given the two records which are most unusual.

[6] One of the most persistent of modern zoological myths—the belief that the rabbit of Porto Santo has developed recognizable characters within historic times—arose from the failure to discriminate between the Mediterranean and central European races of a common mammal.

another must obviously have been greatly facilitated by their possession of wings, may in theory appear plausible enough, but when tested on the actual distribution of the species and subspecies it proves to be of much less importance than commonly supposed; it rests, in reality, on the confusion of two different things: the power of flight no doubt would *enable* a bat to spread over a much larger area than non-flying mammalia, but as a matter of fact, only in a very few cases is there any reason to believe that it has *caused* it to do so.[7] . . . A few of the more striking examples may be mentioned here: a species of *Pteropus* inhabits the island of Pemba, south of Zanzibar, but although the island is separated from Africa by a channel only 35–40 miles wide, not this particular species only, but the whole genus is unknown from any part of the adjacent continent;[8] although absent from Africa the genus *Pteropus* is distributed all over the Malagasy region,[9] and each group of islands . . . has its own peculiar species, intermigration between the groups of islands is unknown; the Epomophorine section of fruit-bats is distributed over the whole of the Ethiopian region (eight genera, nineteen forms), but not a single form has spread to any island of the Malagasy region; the *Pteropus melanotus* group of [five] species is distributed over the Andamans, Nicobars, Nias, Engano and Christmas Island (south of Java), and the whole group is confined to this chain of islands, no form having spread to the neighboring Malay Peninsula or Sumatra. . . . The fruit-bat faunas of the Malay Peninsula, Sumatra and Borneo are closely interrelated, like their mammalian faunas in general, but each has some distinct autochthonous forms of fruit-bats (Borneo even two autochthonous [?][10] genera), as it has of other Mammalia; the Javan mammalian fauna in general is more peculiar, both by the absence of some of the forms found in Sumatra and the Malay Peninsula, and by the greater percentage of autochthonous forms, and this is again borne out by the Megachiropterine fauna of the island . . .; the *Pteropus rayneri* group is represented probably all over the Solomon Islands, but it has differentiated into five distinct species, one in the Bougainville group, a second on Villa Lavella, a third in the New Georgia group, a fourth on Guadalcanar and a fifth on San Cristobal. This . . . tends to show that the present distribution of the Megachiroptera has not been influenced to any great, and as a rule not even to any appreciable, extent by their power of flight; if it had, the fruit-bat fauna of one group of islands could not, so commonly as is actually the case, differ from that of a neighboring group or continent, and the tendency to differentiation of insular species or forms would have been neutralized by the free intercourse between neighboring faunas.

Gerrit S. Miller

[7] The preponderance of bats over the characteristic Indo-Malayan non-volant types in the fauna of the Andaman and Nicobar Islands appears to be an instance in which wings have played a part in distribution (Miller, *Proc. U. S. Nat. Mus.*, XXIV., pp. 790–791, May 28, 1902); the presence of a slightly modified species of *Nycteris*, a characteristic American type of bat, as the only indigenous mammal of the Hawaiian Islands is probably another case of the same kind.

[8] Conversely, six species of European bats (*Myotis myotis, M. dasycneme, M. emarginatus, Pipistrellus natusii, Eptesicus nilssonii* and *Vespertilio murinus*, although occurring on or near the west coast from Brittany northward, are not known to have become established in England.

[9] It ranges eastward "through the . . . Oriental and Australian regions to the Samoa Islands."

[10] Further exploration will probably show that both occur on the peninsula or in Sumatra.

SPECIAL ARTICLES

THE PRODUCTION OF SPERM ISO-AGGLUTININS BY OVA

I. If one allows unfertilized eggs of *Arbacia* to stand in a quantity of sea-water that does not exceed about ten times the volume of the eggs, the sea-water soon becomes perceptibly tinged with the red coloring matter of the eggs. If now a few drops of such supernatant sea-water be added to 2 or 3 c.c. of a milky suspension of active sperm of the same species, a strong agglutination of the sperms immediately ensues, producing sperm-masses easily visible to the naked eye. In the course of three to five minutes reversal takes place, the masses become converted into their constituent cells, and considerable activity may be observed after the reversal on microscopical examination. The substance which produces this phenomenon may be called a sperm agglutinin, and since it is produced by the same species, an iso-agglutinin.

This basic phenomenon was studied in three ways: (1) In a test tube or vial containing 2 or 3 c.c. of a milky sperm suspension, as above described. (2) Drops of the sperm suspension and of the egg-extract may be placed side by side on a slide and connected under the microscope, so as to observe the inception and progress of the phenomenon. (3) The best method of studying the detail of the phenomenon is to mount some of the sperm suspension beneath a long cover glass supported by glass rods 0.5 to 1 mm. in diameter, and to inject a drop of the egg-extract with a capillary pipette into the suspension. If this be observed under a low power of the microscope, one sees that the drop fills with sperm exhibiting increase of activity, which immediately agglutinate into small masses, which then unite with great rapidity to form larger masses spaced throughout the drop. At the margin of the drop and the sperm suspension a ring of agglutinated sperms forms which ruptures in numerous places, each segment contracting to form a mass, so that the continuous ring becomes a chain of beads visible to the naked eye. The ring forms in a second or two and breaks into masses in two or three seconds. The agglutination is totally reversible, so far as the visible effect is concerned, and the freed spermatozoa, or some of them, appear to regain full activity; moreover, the spermatozoa between the masses are in active movement throughout.

The reversal of the reaction consists in the resolution of the agglutinated masses into their individual cells, but this does not mean a return to their original physiological condition; for if the agglutinating solution (egg-extract) be sufficiently strong, after a period of intense stimulation followed by agglutination and reversal, the movements of the spermatozoa gradually cease entirely and in ten minutes they are no longer capable of fertilizing ova dropped in with them.

The agglutination is a factor of (1) the activity and relative density of the spermatozoa in the suspension, and (2) of the strength of the agglutinating solution. The more active the sperms and the greater the density of the suspension (within certain limits) the more rapid is the onset of the agglutination and the larger the agglutinated masses. The agglutinating medium may of course be made to vary in strength, and hence in agglutinating power by various means, *e. g.*, by crushing ovaries and eggs in about their own bulk of sea-water, or extracting in distilled water, very powerful solutions may be made.

The agglutinating agent is not readily destroyed by heat. After boiling and maintaining at a temperature of 95° to 98° C. for about 70 minutes, the agglutinating action of a strong extract was very much reduced but was not entirely lost.

No other tissue of the sea-urchin, so far as observed, produces an agglutinating agent for the sperm of the species: (1) The serum from the body-cavity, whether of males or females, is entirely neutral and the spermatozoa swim in it normally. But the serum forms a powerful agent for extracting the agglutinin from the eggs after the latter are removed from the ovary, though in the intact animal in which the eggs are separated from the serum by the ovarian membrane no extraction of agglutinin takes place. (2) Large pieces of the intestine were cut up in sea-water or in distilled water, the latter especially extracting colored matters in large quantity; but no sperm agglutinin could be detected in the filtrate.

The agglutination reaction fixes the agglutinin, as is readily proved by the fact that it disappears from an agglutinated sperm suspension, if not present in excess. Whereas an equal dilution with sea-water of the original egg-extract is still highly agglutinative. The agglutinative substance, therefore, presumably enters into combination with some sperm substance acting in this respect similarly to its antigen.

II. The results are essentially the same for *Nereis,* except that the visible agglutination is not reversible to the same extent, a difference which is probably of purely secondary significance. Moreover, the agglutinin is produced by the eggs in sea-water only in small quantities before fertilization, but in very large quantities at the moment of fertilization. The eggs of *Nereis* when obtained are in the stage of the germinal vesicle, whereas those of *Arbacia* have formed both polar bodies, and this is probably correlated with the different rates of secretion of the agglutinin. The agglutinin of *Nereis* is moreover much more thermolabile, being destroyed at 95° C. in ten minutes. In *Nereis* also it is difficult to test other tissues satisfactorily, as the animal is practically a bag of eggs when sexually mature, but such tests as were made indicate that the eggs alone secrete the agglutinin. In other respects *Nereis* is a more favorable form for study, as the sensitiveness of the spermatozoa is unsurpassed.

III. As regards the important question of specificity, it seems very probable *a priori* that a substance which is produced only by the eggs of a given species, and which is agglutinative for the sperm of that species should be specific. Now the egg-extract of *Nereis*, which agglutinates *Nereis* sperm, is entirely devoid of agglutinating effect on *Arbacia* sperm, so that there appears to be specificity of the *Nereis* agglutinin to this extent at least. But the egg-extract of *Arbacia*, on the other hand, is extremely toxic and agglutinative for *Nereis* sperm, so that in this case either the agglutinin from *Arbacia* eggs is not specific for its own sperm, or the egg-extract contains, in addition to the specific agglutinin, another toxic substance. The latter alternative is probable, as is shown by the fact that the serum of the cœlomic fluid of *Arbacia*, which is not in the least toxic or agglutinative for *Arbacia* sperm, is as strong an agglutinative agent for *Nereis* sperm as the egg-extract of *Arbacia*. The presence of at least two sperm agglutinating substances in *Arbacia* is therefore certain, viz., one in the egg-extract, which is agglutinative for *Arbacia* sperm, and one in the cœlomic fluid not agglutinative for *Arbacia* sperm but agglutinative for *Nereis* sperm. I assume, therefore, provisionally, that both are present in the egg-extract, and that the sperm iso-agglutinin of *Arbacia* eggs is probably specific.

This assumption is rendered more probable by an observation made only once, and at the end of the season, so that its repetition this year is impossible. I had preserved a strong egg-extract of *Arbacia* for seventeen days. This had been tested at various times with *Arbacia* sperm and found to retain its agglutinating power without any observable diminution. But on the seventeenth day, when the last *Nereis* of the season was brought in, I was surprised to find that the egg-extract in question had lost its agglutinating power on the *Nereis* sperm. The same sperm was agglutinable with an egg-extract of *Nereis* eight days old; so that the difficulty could not be with the sperm. And the same egg-extract of *Arbacia*, on retesting, was found to retain its agglutinating power on the *Arbacia* sperm apparently unaltered. The specific agglutinin is therefore relatively stable with reference to the conditions involved, and the non-specific agglutinin or toxin is relatively labile. It might, therefore, be possible to separate them also by heat or other means.

One of these would be to fix the non-specific agglutinin of *Arbacia* egg-extract with *Nereis* sperm, and test the filtrate for the persistence of the assumed specific agglutinin with *Arbacia* sperm. If the *Arbacia* agglutinin were found to persist after the filtrate had lost its *Nereis* agglutinating power, the presence of the two agents in the egg-extract would be demonstrated. Or if, after completely fixing the specific agglutinin of *Arbacia* egg-extract with *Arbacia* sperm, a *Nereis* agglutinating agent were still found, the same conclusion would be inevitable. Unfortunately, by the time this stage of the analysis was reached, the season for both forms was over, and this experiment must be postponed for a year.

IV. The egg-extracts contain not only an agglutinin for the spermatozoa, but also an aggregative agent, *i. e.*, a substance towards which the spermatozoa are positively chemotactic. This may be readily demonstrated by the form of the reaction when a drop of the fluid to be tested is injected into a sperm suspension beneath a raised cover glass. If an aggregative agent be present, a ring of spermatozoa forms at or within the margin of the drop, depending on the strength of the agent, and a clear zone arises between this ring and the general sperm suspension. The clear zone is produced by migration of spermatozoa to the ring; in case the agent is very strong the ring expands, owing to immigration of spermatozoa, but the clear zone is never obliterated, no matter how much the ring may expand. In the case of *Nereis,* which has unusually large spermatozoa, the passage of spermatozoa across the clear zone to the ring may be readily studied under a low power of the microscope, and it gives the impression of a regular rain falling on the ring.

In the case of *Nereis* all acids tested are aggregating agents (CO_2, H_2SO_4, HNO_3, HCl and $CH_3 \cdot COOH$ were studied), but do not agglutinate, and alkalis (K, OH and NaOH only studied) are agglutinative but not aggregative. The sperm of *Nereis* is extremely sensitive to acids, reacting positively to *N*/1,000 H_2SO_4, HCl, HNO_3 and *N*/2,000 acetic, and to 1/200 dilution of a saturated solution of CO_2 in sea-water. The phenomena of aggregation were therefore studied, particularly in the case of *Nereis.* The sensitiveness of *Arbacia* sperm to acids is three or four times less than that of *Nereis* sperm, but the reactions are in the same sense.

If an acid or other aggregative agent alone be present in the drop tested in the suspension beneath a raised cover slip, the ring which forms is perfectly continuous and the individual spermatozoa are separate. If an agglutinin as well as an aggregative agent be present, the ring forms and breaks up into agglutinated masses. If the agglutinin alone be present no ring proper forms, or there is no outer clear zone, and agglutinated masses form within the drop as described. The egg-secretions give the double reaction.

V. Von Dungern's experiments (*Zeitsch. f. allgem. Physiologie,* I., pp. 34–55, 1902) are the only ones, so far as I know, in which the production of sperm agglutinins by ova was investigated, and he discovered only hetero-agglutinins, no iso-agglutinins. He did, indeed, describe the loss of motility of spermatozoa in egg-extracts of the same species, but he entirely missed the phenomenon of agglutination and its reversal. He reveals the reason for this failure by his remark that he always examined for the effect of the "egg-poison" about half an hour after its addition to the sperm; but the phenomenon of agglutination and its reversal are completed in about five minutes.

Von Dungern also made experiments on the production of immune sera by injection of ova and spermatozoa separately into rabbits, and found that both caused the production of a sperm agglutinin in the rabbit's serum. From this he concludes that both kinds of reproduction elements possess chemically identical complexes of molecules in the protoplasm. While this may be admitted as at least a very probable conclusion, his farther conclusion that fertilization does not depend upon any specific antagonism between ovum and sperm, but is conditioned by the similarity of their protoplasms, is not well founded, for the egg is a very complicated chemical system, and it certainly contains molecules antagonistic to sperm, even if, as von Dungern's experiments indicate, it also contains some that are not.

VI. The existence of sperm iso-agglutinins in ova offers the possibility of an explanation of the specificity of fertilization on the basis of the laws governing antigens and antibodies, if these agglutinins are specific, as is so strongly suggested by the experiments. The union of ovum and spermatozoon is not a process in which the sperm penetrates by virtue of its mechanical properties, but one in which a peculiarly intimate and specific biochemical reaction plays the chief rôle. A later publication will give the details of the experiments and a more complete analysis of the behavior of the spermatozoa in fertilization.

Frank R. Lillie

September 16, 1912

PRELIMINARY NOTE ON PRISTINA AND NAIDIUM

These two genera, *Pristina* and *Naidium,* of the aquatic oligochætes, have been combined and separated by recent systematists with quite startling rapidity. The former genus was first described by Ehrenberg in

1831, and *Naidium* by O. Schmidt in 1847. In 1875, Beddard combined them under the prior name. In 1900, Michælsen restored them as separate genera, and again combined them in 1909. These two genera are more alike than any other two genera in the family Naididæ, and than many species in some of the genera. They differ only in the development of the prostomium, which varies widely within the same species, and in the presence of bifid setæ in the dorsal bundles of *Naidium*. This is no more reason for keeping them apart than it would be to make *Nais tortuosa* and *N. parviseta* separate genera, because the latter has bifid setæ in the dorsal bundles. Michælsen, in recombining the two species, gives no reason for so doing; but Walton (*American Naturalist*, Vol. XL., 1906, p. 705) says:

> The absence of any tentacular process in *Naidium osborni* suggests that until a species is found in which the process is well developed and in which the dorsal bundles contain biuncinate setæ, the genera may be considered distinct.

Walton prophesies the finding of such a species, and apparently suggests the inference that when such a species is found the genera need no longer be considered distinct. This species has been found and will be more fully described in a later paper on the Naididæ. It was found at the University of Virginia in the spring of 1909, in an aquarium stocked from a small pond in the neighborhood. It differs from *Pristina breviseta* of India only in length, being considerably shorter, not exceeding 8 microns in length, but is otherwise identical and it seems best not to establish a separate species to receive it. In the American forms of this species the tentacular process varies greatly in length. In one individual it was not developed at all, in others it was developed to a length of several microns, and intermediate lengths are numerous. There are always, however, the bifid needle-like setæ in the dorsal bundles. But if we are to make this a generic character, why not make the presence of serrations on the capilliform setæ a generic character? And while we set off those forms with the bifid setæ in the dorsal bundles and no well-developed tentacular process, what shall we do with *Pristina dadeyi*, which has neither tentacular process nor bifid dorsal setæ? Michælsen's recombination of the two genera, therefore, is confirmed by the finding of this form, and it is correct to include under the head of *Pristina* all the species hitherto described under the heads of *Pristina* and *Naidium*, whether the prostomium be tentacular or not, whether the capilliform dorsal setæ be serrated or not, and whether the dorsal bundle contain a bifid needle-like seta or not. These characters are found in parts which vary greatly and the great resemblances among the various species in the position of the setæ and of the internal organs are more important.

Horace Edwin Hayden, Jr.
College Station, Texas

CONCURRENT INFECTION BY FIVE SPECIES OF INTESTINAL WORMS, INCLUDING SCHISTOSOMA MANSONI

Instances of the presence of two or more species of parasitic worms in one person are common and many such are on record. To cite some of the more recent literature, Garrison and Stiles, '06, in an examination of 3,457 persons, found that thirty-five harbored two species of intestinal parasites and that one was infected with three species. The Porto Rico Anemia Commission, in the course of its very extended studies, found frequent instances of double infection, not rarely triple infection, and, in two cases, determined the presence of four distinct species. Piraja de Silva, '09, working in Bahia, Brazil, reports several similar cases of quadruple infection. A case which has recently come to my attention is of interest not only as an extreme case of concurrent infection but as one of the few known instances of the occurrence of the blood-fluke, *Schistosoma mansoni*, in the United States.

On May 3, a local physician sent to me, with the request that I make a blood examination, a Porto Rican who exhibited obscure symptoms suggestive of filarial infection.

The patient, who was a young man twenty-five years of age, had been in this country for five years, except for three brief visits home. The fresh blood was carefully examined and smears to be stained were made, but on account of the well-known periodicity in the appearance of filariæ in the peripheral circulation, the patient was requested to return at night.

In the meantime, the blood smears were stained with the Nocht-Jenner-Hastings stain and examined for possible malarial parasites. None were found, but there was a marked eosinophilia (20 per cent.), such as is often due to infection by parasitic worms.

When the patient returned, a search for blood filariæ was made, with negative results. On account of the eosinophilia, a sample of the feces was then examined microscopically. In this were soon found the large, characteristic eggs of *Schistosoma*, a very few of *Ascaris lumbricoides*, and many larvæ of *Strongyloides stercoralis*, the Cochin China diarrhea worm.

When the result of the examination was reported to the physician in charge of the case, the usual treatment with purgatives and anthelminthics was adopted. Unfortunately, the patient made no effort to save the specimens dislodged, except that a sample, taken some hours after the treatment, was sent me. In this sample the three species above mentioned were present, the number of larvæ of *Strongyloides stercoralis* being much larger than in the first sample. In addition, there were found a small number of the eggs of the hookworm, *Necator americanus*, and of the whipworm, *Trichuris trichiura*. I afterwards learned that following the medical treatment, a full-sized *Ascaris* had been voided.

Thus this patient harbored five distinct species of parasitic worms, differing from the two cases reported by the Porto Rico Anemia Commission by the presence of the larvæ of *Strongyloides stercoralis*. Excepting those of *Schistosoma*, the eggs of the various parasites were but few in number.

The many eggs of *Schistosoma* were *all* lateral-spined. In view of the discussion as to whether this type of eggs is from a species distinct from *Schistosoma hœmatobium*, a careful examination of the urine was made. No eggs or traces of them were found, although it is here that the typical, terminal-spined eggs of *Schistosoma hœmatobium* are most readily demonstrated. Neither was there any history of bloody urine, or evidence of blood corpuscles in the fluid—symptoms commonly associated with the presence of the ova of *Schistosoma hœmatobium* in the urinogenital system. This is in agreement with the evidence recently brought forward by Sambon, Holcomb and others to show that the West Indian and South American schistosomiasis is due to a distinct species, which also sometimes occurs in association with the better-known species in Africa. To this species with lateral-spined eggs, Sambon, '07, gives the name *Schistosoma mansoni*.

The few records of the occurrence of *Schistosoma* in the United States are all, like the above, of imported cases. Most of them are recorded from transient visitors, or from soldiers returning from South Africa, and refer to infection by *Schistosoma hœmatobium*, terminal-spined eggs having been found in the urine. Wm. A. Riley

SOCIETIES AND ACADEMIES

THE ELISHA MITCHELL SCIENTIFIC SOCIETY

The 29th annual meeting of the society was held on September 27 in Chemistry Hall, University of North Carolina, with the president, Dr. W. B. MacNider in the chair. The following officers were elected:

President—Dr. E. V. Howell.

Vice-president—Professor P. H. Daggett.

Permanent Secretary—Dr. F. P. Venable.

Recording Secretary—Dr. J. M. Bell.

Editorial Committee—Dr. W. C. Coker, Professor A. H. Patterson, Dr. J. M. Bell.

The following new members were elected: Dr. W. H. Brown, Messrs. T. R. Eagles, J. W. Lasley, J. G. Beard, A. M. Atkinson, C. S. Venable, J. E. Smith, W. C. George.

James M. Bell,
Recording Secretary

Chapel Hill, N. C.

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THE MIGRATION OF STUDENTS[1]

A PLEA FOR THE INDIVIDUAL IN EDUCATION

The chairman of our judicial council, Dr. Means, in a recent address on "The Relations of the Medical Colleges in the Matter of the Migration of Students," has stated that these relations should be adjusted on the basis of the Golden Rule. With this I heartily agree. I would, however, call attention to the wording of the Golden Rule, "Do unto others." This seems to imply that our relationships are multiple rather than duplex.

There is hardly a problem in ethics to be settled on the basis of "Thou" and "I" alone. No case of migrating students should be considered from the standpoint of the colleges alone. In every instance the public or state has a claim on our consideration, for we are the servants of the state in the making of physicians.

We are also in a peculiar and intimate degree responsible to the student himself. We take his money; we take what is more valuable than money, his time. We modify his whole life. To take out the human element from our work; to claim that the student acts always of his own free will; to make our colleges by inflexible rules mere mechanisms for grinding out as doc-

[1] Read before the Association of American Medical Colleges, March 1, 1912. Readers of this paper should bear in mind the legal restrictions on medical educational institutions, which other departments of education are not subject to. These cover such topics as length and number of yearly sessions required for graduation, admission, advanced standing, credit from other institutions, etc. It should also be noted that medical schools have on their faculties numerous professors who are primarily in medical practise and only incidentally acting as teachers.

tors those individuals alone who can fit the hoppers and cogs of the machine—to do these things is to take away all proper significance from education.

The more I consider it the more I am convinced that our personal duty to the individual student is our fundamental duty. If we can do right by the individual student, we shall do right to the other colleges and to the state. If we do right by the individual student, we shall see that his obligations are met; that his deficiencies are made good; that he is protected from his own misdirected inclinations; that he is kept, if need be, from a profession for which he is not fitted. I propose, therefore, to discuss the subject assigned to me from the standpoint of the individual student.

I would strongly emphasize that my argument is not to favor lower standards. The poor-boy story and the easy pathways to practise do not appeal to me. Any one who draws from my expressions regarding the rôle of rules and regulations the conclusion that I favor the removal of the safeguards to medical practise wilfully reads into them what is not there. On the contrary, I believe that the efficient judgment of the individual case, whether by entrance examiner or faculty or state board or all three of these, would constitute the best possible safeguard and one which ought to be added to the regulations and examinations, which at present constitute the chief protection against the inefficient and unprepared.

Strictly speaking, there is no such thing as equality. Variation holds everywhere in the social world, as it does in the animal and plant world. Every case is an individual case. Education will reach its highest when it becomes individual.

The individual student is not the student *en masse* nor the average student. The individual student means individual consideration. He means the breaking loose from rules and the consideration of pertinent facts. He means the application of principles rather than formulas. He is a difficult problem not to be solved by engineering handbook nor plotted in two dimensions.

I am provoked just here to the further platitude that we have in our political and social life, as in education, too many rules, too many laws, regulations, prohibitions. (I suppose this is because we are so infernally human that we can not be trusted to apply the Golden Rule, which our chairman rightly considers our standard.) At the same time that we are burdened with laws we have no adequate mechanism for securing justice to the individual. This is true in every relation of life.

Let us glance for a moment at the legal restrictions placed upon medical education. The law compels every man who desires to enter the medical profession to attend four sessions in a medical school. It takes no cognizance of the fact, recognized, I am sure, by every man here, that some men would be competent in three years, more competent, in fact, than others in thirty years.

The law provides that the four sessions shall be in four separate calendar years and disregards the fact that some students could work to advantage eleven or twelve instead of eight or nine months in a year. Why should the law permit the doctor to practise twelve months in a year but allow him to study only eight or nine?

The laws[2] do not permit that any time credit be given for attendance in a college of arts or science, yet in particular cases the work done there is better than that of some medical schools.

[2] True of most states. The laws of a few states still permit graduates in arts or science to obtain the M.D. in three years.

Now, I am not arguing that these laws are bad. Some of them are undoubtedly artificial. But even these have probably been necessary as applied to average students and average colleges. The trouble is that no arrangement is provided by which the particular case can be excepted. The law, we are told, is no respecter of persons. So much the worse, I retort, for the law. And the law by the way is beginning to recognize this fact, as witness the more enlightened way in which it is beginning to deal with juvenile offenders. Each case is settled on its merits and by careful judgment of experts.

In our association also we have laws. With much labor we have formulated a curriculum from which no college can deviate in any particular more than 20 per cent. Yet to-day I have in my laboratory a young man who shows talent as an investigator. He desires to become and I am sure will become a professional physiologist or pharmacologist. I should be a traitor to my science if I compelled or advised that young man to take the straight, fixed curriculum. He should have a special course laid out to meet his special needs.

But some one objects, "This is unsafe; this young man may later go into practise." My critic is laboring under the belief that our fixed curriculum contains all the subjects and only the subjects without which one can not safely go out as a physician. My answer is, I know the man and his ability. The curriculum, I may further remind my critic, is literally a race course. We do not use the same kind of track for automobiles and aeroplanes and steam yachts.

This criticism and my answer to it lead me to state the first condition for dealing properly with the individual student, whether as regards curriculum, migration or any other matter. *Some one has got to know that student and the facts about him.*

A second critic may have said to himself when I suggested a special curriculum for my student in physiology, "It will be against the Constitution of the Association." My reply is, in the famous words of the practical statesman, "What is the constitution among friends?"

And that leads me to enunciate the second condition for dealing with the individual student. *There must be a body of friends, friends of the student, friends of education, friends of the public, who shall determine when, where and how the constitution (i. e., the rules and regulations) may safely be broken.*

You catch the drift of my thought: a college may be run in two ways. It may be run by inflexible rule. Students are received, classified, advanced, rejected, graduated, by regulation and statute. All that comes in, whether iron, steel, lead, copper, brass, silver or gold, is drawn through the same hole to wire of the same size. Such a college is not a human being. It is a machine, and it makes no mistakes. It needs no intelligent supervision. You just start the wheels going and watch the rollers turn merrily on.

Or a college may be run for the individual. It may have small regard for paper standards, have few regulations, have a flexible curriculum, care little for classification, permit specialization. It may make wire of iron and steel. It may turn the lead over to the plumbing industry. It may make scientific apparatus of its copper and brass. It will surely make jewels of its silver and its gold. Such a college is human. It makes judgments, choices, designs. It is not a machine, and it makes mistakes. It can only avoid making many mistakes by the most intelligent supervision and the combined judgment of experts.

If I may change my figure of speech, the rules, regulations, precedents and formulas for running a school correspond to the reflex mechanism in an animal. They adjust it well to the average conditions of environment and govern certain subordinate functions. But the animal which is purely reflex stands low in the scale. And so does the college that runs by rule and formula. What is needed in the animal is a superposed cerebrum, which can inhibit reflexes and regulate behavior in accord with a greater complexity and continuity of stimuli. Speaking as a man of the street—and not as a scientist nor as a theologian—what the animal needs is a soul. And that is just what the college needs. The soul of the college should be such an organization of experts as can exercise safe and sane judgment under varying conditions. This paper will be concerned, first, with the organization of such a body of experts; secondly, with the methods to be used by them in taking care of migrating students.

Regarding the first topic, organization, I believe that it is unsafe to leave to the dean alone the decision of important matters relative to the individual student. The dean even in the case where he devotes a large share of time to his office can not know the work of the student in all departments. He may, it is true, have the record of grades, but these are not the intimate personal data on which the individual case must be settled. The grades constitute a part of the regular reflex machinery which disposes very well of the average student. They are of value, but should not be the sole criterion for deciding questions regarding particular students.

Another reason why the important individual case can not be left to the dean is that he is almost always a professor, and looks with the usual jealous but magnifying eye on the importance of his own department. The individual student must be considered from all sides.

If the dean can not dispose properly of the individual student, much less can a secretary or registrar, who is usually not an educational officer in the proper sense, but strictly a part of the reflex machinery.

The individual student, furthermore, can not be considered properly by the faculty. This is not easily done in a school of arts or science, and is even less feasible in the average medical school, where many of the professors are in medical practise and give only a portion of their thought to educational problems. The word of a clinical professor lecturing one or two hours a week is of less value as regards an individual student than that of a paid assistant who meets the student daily in the laboratory. Moreover, faculties meet infrequently, and the individual case needs immediate consideration and action.

A committee of the faculty, provided it has power to act, can do the work better than the faculty, but here again there are objections. The faculty usually consists only of professors, and a large proportion of them do not come into intimate contact with the students. The committee is likely to partake of the same character and often degenerates to one man control.

Finally the case of the individual student should not be referred piecemeal to the individual department heads. Take the case of a migrating student, for example. If he is sent in turn to the professors of chemistry, anatomy, etc., each settles his part of the case without reference to the others. One exaggerates the value of his own teaching and will give no credit for work done in another laboratory. Another is too lenient or does not wish to be bothered. Conditions are imposed without regard to general time schedule, and no consideration is given to the character and needs of the particular student.

The case of the individual student should be referred and the power to break rules and precedents should be given to those who by training in educational methods and experience with students know the individual case and what may safely be done. These are essentially the paid, full-time instructors, with such few others, perhaps, as have demonstrated that they are pedagogues as well as practitioners. The full-time instructors are educators, not physicians. They are paid to do work of the kind we are considering as part of their "teaching." They can be called together frequently.

In the school that I represent the paid teachers (with the addition of four heads of clinical departments) constitute the council. All paid teachers except student assistants are included. This council has full power to settle all questions relative to students. The remainder of this paper will be chiefly concerned with the methods by which the council disposes of migrating students.

In presenting the work of our Council I would particularly disclaim a new discovery in education. Somewhat similar methods are used elsewhere. Nor would I claim that our organization in its exact form should be generally adopted. Each school must work out that form of government which best suits its environment. I use my illustrations from my own experience not because they are noteworthy or unique, but because they constitute my store of available facts.

Taking up now the specific topic of discussion, migrating students may be classified as follows:

1. Good students who come from "good" schools.

2. Poor and doubtful students who come from "good" schools.

3. Students who come from "poor" schools.

(By "good" school, I add parenthetically, is meant a school which one considers as good as or better than the particular school one individually happens to represent! I consider Western Reserve a good school. My friend Waite considers St. Louis University a poor school. I pass on the compliment by considering certain nameless institutions poor schools. The point is that in this matter of migrating students the American Medical Association classification is of little value.)

Referring to my first class of migrating students, it is a lamentable fact that few good students come from good schools. The migration of students for the sake of coming under different environment, varying methods and special professors, so common in German universities, is almost unknown in America. This type of migration has always been discouraged by the colleges, and the fixed curricula have not facilitated it.

A few good students change colleges for reasons unconnected with education. A few change on account of legitimate personal grievances. (I can not agree with Dr. Means, who states that he has never known such a case. On the whole, however, we will all agree that tales of personal grievance are to be taken in homeopathic doses, with plenty of water.) Whatever be their reason for changing, provided it is honorable, the good students who come from good schools should be accepted on the basis of equivalence of discipline, rather than exact equality of subject matter. If the student, let us say, has had 600 hours of anatomy and 500 hours of physiology, whereas your curriculum requires 1,000 hours of anatomy (heaven save you!), and only 300 hours of physiology (heaven save you again!), it is neither necessary nor just to condition the student in anatomy. If you are satisfied that the teaching is good and thorough in the other school, you can overlook differences of this kind. Of course if some important subject has been omitted on account of difference of curriculum, it must be made up. On the whole, the good student should slip in easily on his record.

Allow me to introduce here a paragraph on the general subject of migration of good students. I believe it should be encouraged. If we could implant the idea that the goal of the student's desire should be thorough knowledge of anatomy, of physiology, of medicine, and not the possession of a certain piece of sheepskin, we should be on the way to better things. And if to the student specially interested in physiology I should say: "Professor Blank is one of our best physiologists; why don't you take a year with him?" I should be giving scope to that student's interest and broadening my science at the same time. If we proceeded in this way, the time might come when students would select men instead of schools. And when that time comes, a professorship will be worth working for and worth working to keep, having been attained. When those good days arrive, we shall not find it so difficult, perhaps, to find men willing to enter the laboratory sciences as a career. But whether these good results follow or not, I believe that the migration of students should be encouraged from the standpoint of breadth of culture and training. And our purely American whoop-it-up notion of "college spirit" and school loyalty should be somewhat abated in favor of a better ideal.

Taking up the second class of migrating students, the poor students from good schools, we have our most difficult proposition. When a man with a poor record comes from Washington University or Michigan or Missouri, I have chills. And when he tells me he comes because of our superior facilities, I have an internal spasm. Such a man may have a "good constitution." He may "recover," but the prognosis should be "guarded." The council of our school has, therefore, found it necessary to decline to receive such students into our senior class. The reason is based on my first principle enunciated above. We must know the student, and we can not do that in the senior year.

A second provision is that much of the credit allowed is contingent. For example, histology may be credited, provided the student makes a good grade in pathology; or credit in dissection may be made contingent on topographical anatomy. We believe this arrangement is logical, and it certainly has a good effect on the student.

If the student has a failure from his former school, he is obliged to take further work in that subject. But we have no hard and fast rule about repeating laboratory courses. Too much repetition of elementary work is discouraging. Short special courses are better; and we have frequently organized such courses, primarily for the third class of migrating students, but to the great advantage also of the second class.

Even if the student is to be classed as a junior, we always hold him for one intensive laboratory course, commonly topographical anatomy (cross sections), which is a hobby of ours and on which we have a taskmaster not to be evaded, tricked or cajoled.

We find our summer school of great value in whipping delinquents into line. This is true both of our own backward students and of those who come from other colleges.

Taken all in all, the second class of migrants are not altogether a discouraging body of men. Frequently they see the error of their ways and settle down to business. Sometimes discouragement in one environment is followed by a better spirit under new conditions. The mentally deficient, the ill prepared, the congenitally slothful, the habitually dissipated, must of course be dropped. Our primary idea is to keep the student long enough under the close supervision of the paid instructors to know whether these qualities were the cause of the original failure.

The third class of migrating students includes those who come from poorer colleges. Mr. Flexner has discussed these in some detail. He shows how a student who originally could not enter a college may eventually come in with advanced standing through attendance in one or more inferior institutions. The student thus evades the rules of entrance of the first school. This seems deplorable and is certainly unfair to the other students who were obliged to come up to the standard of preparation before entering their freshman year. And for the particular condition that Mr. Flexner discusses, there is only one proper procedure, and that is to enforce the same rules of preliminary education on students who enter with advanced standing as on those who enter the freshman year. I shall say nothing further on this point.

On the other hand the assumption that a student from an inferior school is himself necessarily inferior is absolutely wrong. In fact, my experience is that such a student is generally a very good man who desires to better his condition. And in contrast to the heart failure with which I meet the incoming migrant from Michigan, might be mentioned the welcome accorded the students from several nameless institutions.

Now, how should such a student, as an individual, be dealt with in justice to himself, to the college and to the public? As to the public, it is plain that the student should not be graduated till he is competent. As to the college, it is evidently bad policy (to put it narrowly) to graduate him before he is safe. As to the student, he has put in his time in the inferior school and has presumably gathered something. To refuse all subject credit and make him repeat all the previous work arouses revolt, and in my opinion is unjust. To refuse or diminish time credit beyond what is needed to know the student and his capabilities is also wrong. Time is not money, gentlemen. Time is life, and not to be handled carelessly; not to be required of the student as from inexhaustible store, but rather as that which not enriches us but makes him poor indeed.

I shall be obliged to discuss this class of students, as previous ones, from the standpoint of my own experience. The student is brought before the council; his credentials and grades are presented; he is questioned as to the nature of his previous work; and the decision, which is always a tentative one, is based not upon fixed rules, but upon careful consideration of that case.

The principle of contingent credit is frequently applied. For example, credit in dissection, if he passes in topographic anatomy. This procedure is safe, and it is sound pedagogically.

The principle of additional required laboratory work is applied, particularly by demanding attendance in summer school or on short special courses.

The principle of examination is applied, but not universally. For example, I frequently credit a student in freshman physiology if he passes on the sophomore work, although the topics considered in the two courses are different. I think I can discover whether he can think physiologically as well from one part of the subject as another.

The principle of requiring a sufficient attendance to give us knowledge of the student is insisted on. No student from an inferior college is received into the senior year.

To the furtherance of our knowledge of the student's ability as a laboratory worker, we always require at least one complete laboratory course, even if the student is admitted to the junior year.

On the other hand, we are not particular that every course which the student has had shall be of the same length, character and strength as our own. If he has had a fair course in bacteriology, but not so good as ours, I am willing to give him credit and let him take instead an intensive course in, let us say, pharmacology. Our idea is equivalent discipline, not parallelism of curricula.

That the students from poor schools have usually succeeded is shown by our experience during the past five years. The leader in our present senior class is a student who came into our junior class last year from a school which would be unrecognized by many members of this association. Of course, some have fallen by the way, and either voluntarily withdrawn or been dropped by the council.

There are a few more self-evident propositions to be considered. For example, the school from which the student comes should be conferred with. Not only should the grades of the student be asked for, but all facts concerning him which will assist in properly disposing of his case. That all obligations to the first institution, including the payment of fees, should be satisfied, is a clear demand on the student as an honorable man, seeking to enter a gentleman's profession. We should refuse him unless he meets such obligations.

There are certain institutions, on the other hand, which refuse to respond to requests for grades or information regarding students who wish to enter another school. I hold that such students may properly be received on their class grades or attendance certificates only.

In the enjoyable correspondence which I have had with Dr. Means in regard to this paper, he has raised several specific questions of interest. "For instance," he says, "a student applied for admission to the Starling-Ohio last fall with credentials of having completed his sophomore year and wanted junior standing. The card showed six or seven conditions on regular examinations, and that they had been removed by subsequent examinations—three or four subjects requiring two efforts. I could not have given him," continues Dr. Means's letter, "more than sophomore standing, which he refused to accept and returned to his old college."

This is one of my heart-failure cases. I believe the best way would be to refuse the student altogether. But we have never reached that stage yet. Our council would probably have allowed the student two years' time credit, but we would have loaded him up with conditions and summer-school work enough to test him pretty thoroughly. Dr. Means's even more drastic action is commendable. One thing is certain; if you grant these students full junior standing, you will suffer for it. You can not catch these migratory birds in the junior and senior years. The cages are too full of holes.

This case brings up another topic, that of giving students passing grades on condition that they go to some other school. This is a despicable practise. Some schools not only pass on their lemons to other institutions, but give them certificates as oranges. We ought to swear by the shade of Hippocrates never to be guilty of that injustice—for injustice it is to the student, to both colleges and to the public.

Another experience is that which Dr. Dodson and I so frequently had at Rush Medical College ten years ago. A certain university gave only the final standing of the migrating student, without stating that he had been conditioned or failed and subsequently passed. It did not give numerical grades, but merely said "passed." We were led to suppose that such men were all right, whereas they had been weak students with repeated deficiencies. It was only after much disastrous experience that we learned the truth. In St. Louis I had similar experience with schools which gave credentials indicating the final standing but not the intermediate deficiencies of students. This practise seems to accord with the gold-plated rule, "Do others." The credentials should show every condition and failure, whether removed or not. Every important faculty action should also be set down, such as required repetitions, demanded withdrawals, etc.

Should the receiving school be governed in its treatment of a student by the advice of the school from which he comes? Theoretically we may answer "yes." But in my experience, the latter institution, as a rule, has little advice to give. It is usually glad to get rid of the man and does not care what becomes of him. There are, of course, exceptions; and in such cases the credentials and correspondence should be of great weight in deciding the action of the receiving institution. On the other hand, standards and methods vary; and I do not think a college has necessarily just cause for complaint if its emigrating student is received on different terms from those which it would itself impose on him.

An interesting case somewhat under this category has occupied the attention of Dr. Barlow, Dr. Means and myself this year. A student spent three years at the Los Angeles Division, University of California. He passed with good grades in all except three minor subjects. In these branches he failed to attend 80 per cent. of the exercises, as required by the college and the California statute. The faculty, therefore, ordered that he repeat the junior year.

This student came to St. Louis, giving as his reason the fact that we have a summer school, and that he desired to make up his time deficiency by attending a summer session. In addition to credentials and letters establishing the above facts, he presented letters from the instructors in the branches mentioned, stating that he had done the work and had passed the examinations, but that these were not allowed to stand on account of deficiency in time requirements, as previously stated.

Our council went over the case and voted that he should be admitted as a conditioned senior, with the understanding that he should take a summer course and, if all his work proved satisfactory, should be graduated at the close of the summer school. It was further provided that this action should be contingent on its approval by the dean of the Los Angeles Division, University of California.

I submitted the action to Dr. Barlow. He submitted it to the California Board and the board submitted it to the chairman of the Judicial Council of this association. As a result our action was not approved, and we were obliged to classify the student as a junior.

Now I have nothing to say as to the disapproval of our action. I have no doubt the disapproval was founded on the state law and could not be avoided. What I do maintain is that so far as the good of that student was concerned, our action was justified by all the circumstances; and if there were any national body, similar to our school council, clothed with power to consider the individual case and settle it on its merits, this young man would probably have been saved one year of valuable time.

It is of course easy to answer that the man knew the rule and should have governed his attendance accordingly. But from my point of view the rule is a device for securing proficiency. As a general thing it promotes proficiency and is therefore a good rule. But in this case it was not necessary, as the documents show. Justice to the individual, therefore, made it desirable that the rule be not enforced. You say this would create a bad precedent. I answer it would create a good precedent that, for good reasons, exception may be taken even to a good rule.

Dr. Means has asked me to comment also on the action of the instructors who gave the young man statements of having passed their courses subject to the time requirement above mentioned. As I do not know the conditions at the Los Angeles school, I think it would be unfair to express a specific opinion. In general it may, perhaps, be claimed as the just prerogative of an instructor to give to any student a statement of the work he has done and the proficiency attained while studying under that instructor. For administrative reasons, in schools hemmed in by legal restrictions like our medical schools, it is well that this prerogative be exercised with caution. In our school it is a matter of custom that no grades be given out by the instructors. If any chose to do so, I should not complain. But it is clear that a grade so given does not constitute school credit, for that depends on other factors, such as registration, payment of fees and legal attendance.

SUMMARY

Migrating students have been divided into three classes. The good students who come from good schools should be accepted on the general principle of equivalence of discipline rather than exact parallelism of courses of study. Migration of this kind of students should be encouraged. Poor students from good schools, what Dr. Means calls "lame ducks," need very careful consideration and supervision. Their standing should be provisional and contingent on good work. Each case should be considered on its merits, and the student given a fair opportunity to redeem his record. But he must be held rigidly enough to test his ability and knowledge. It is not wise to take such students into the senior year.

The third class consists of students from inferior schools. It can not be ascertained in advance whether they are capable or not, as the grades from many of these schools are of no value. These students likewise should not be taken into the senior year, but by two years of selected work, supplemented in many cases by summer school, many of them can be graduated on a par with the regular members of a class. These students are usually men who made a mistake in their original choice of a school and who are earnestly desirous of bettering their condition. Each student must be considered individually, and his credits and studies adjusted to meet his personal needs. Hard and fast rules can not be followed, but certain principles find more or less general application. These are considered in the body of this paper.

For the adequate consideration of the individual student, whether in the matter of migration or any other phase of school life, a body of trained educators must be constituted with ample powers. It is recommended that this body be composed primarily of the paid, full-time instructors. In most medical schools this would not be too large a number to be effective. This body should be free to use its judgment for the best interests of the individual student. Rules and precedents have their value for the regular progress of the student body, but must be considered a means and not an end. Justice to the individual is our fundamental duty. Broadly considered, just action for the individual carries with it justice to the other schools and to the public. We must beware lest in our blindness and in our sloth and in our preoccupation we bow down to the wood and stone of rules and regulations. Let us set up rather the god of individual education, which is a spirit and not a formula; the spirit which so successfully wrought in medical education in the days of preceptor and student; the spirit which has produced such apparent prodigies as Carl Witte and young Sidis; the spirit which makes an educational institution, not a machine nor a purely reflex organism, but a human entity with a human soul.

E. P. LYON

THE GEOGRAPHICAL DISTRIBUTION OF THE STUDENT BODY AT A NUMBER OF UNIVERSITIES AND COLLEGES

THE accompanying table explains the geographical distribution of the student body of twenty-four American universities, five New England colleges for men, five colleges for women, one eastern and one western school of technology and one Pennsylvania college and engineering school, for the academic year 1910–11, the summer session students being omitted in every instance. The corresponding figures for 1909–10 were not compiled; those for 1908–9 may be consulted in the issue of SCIENCE for October 1, 1909, those for 1907–8 in the issue for October 30, 1908, those for 1906–7 in the issue for July 26, 1907, and those for 1904–5 in the issue for October 6, 1905. To the table for 1909–10 have been added the University of Syracuse, the University of Texas and Washington University, St. Louis.

Comparing the attendance by divisions of six eastern universities (*Columbia, Cornell, Harvard, Pennsylvania, Princeton, Yale*) with the corresponding figures for the same universities in 1908–9, we note that there has been a gain for these universities, taken as a whole, in every division, the largest increase in the actual number of students, leaving the North Atlantic division—in which all of these six universities are located—out of consideration, having been recorded in the North Central division, where there has been a gain of 310 students. The South Atlantic division comes next, with an increase of 126 students, followed by the Western division with a gain of 117 students, the South Central with 89, foreign countries with 27 and insular and non-contiguous territories with 23. The total increase in divisions outside of the North Atlantic in the two years under comparison is 692, as against a total increase of 527 in 1908–9 over 1906–7. Calculated on a percentage basis, the total gain of the six universities in the North Atlantic division between 1909 and 1911 amounted to 11.6 per cent., as against a gain of 13.3 per cent. outside of the division mentioned. In 1908–9 the percentage of increase in the North Atlantic division over 1906–7 was 7.6 per cent., as against a gain of 11.4 per cent. in the other divisions combined. In the North Atlantic, South Atlantic and North Central divisions and in the insular and non-contiguous territories all of the six universities with the exception of *Yale* show an increase in 1911 over 1909; in the South Central division all of the six institutions have made gains, in the Western division all show an increase except *Princeton,* while in foreign countries all have experienced gains except *Pennsylvania.* Comparing the figures for 1910–11 with those for 1904–5, we observe that the most substantial gains have been made by *Pennsylvania* (96), *Columbia* (92) and *Cornell* (63), in the South Atlantic division; by *Columbia* (61), in the South Central division; by *Columbia* (252), *Cornell* (175), *Harvard* (132) and *Pennsylvania* (64) in the North Central division; by *Harvard* (60) and *Yale* (52) in the Western division; and by *Pennsylvania* (79), *Columbia* (74), *Cornell* (61) and *Harvard* (60) in foreign countries.

Of the western universities, *Michigan* has by far the strongest hold on the North Atlantic division, attracting 638 students (as against 394 in 1905), to *Wisconsin's* 96, *Ohio's* 86, *Illinois's* 76 (36 in 1905), *Northwestern's* 64, *Stanford's* 49 and *California's* 34. Of the universities *Harvard* leads in all of the New England states with the exception of Connecticut, where *Yale* has the largest following, and of Vermont, where *Syracuse* is in the lead. *Columbia* naturally has a considerable lead in New York and New Jersey, while *Pennsylvania* of course leads in its own state. In New York *Columbia* is followed by *Syracuse, Cornell, Yale, Harvard, Michigan, Princeton, Pennsylvania.* In New Jersey *Columbia* is followed by *Pennsylvania, Princeton, Cornell, Yale, Harvard, Syracuse.* In Pennsylvania the University of *Pennsylvania* is followed by *Cornell, Princeton, Yale, Harvard, Columbia, Michigan, Syracuse.*

Examining next the attendance of the group of male colleges and technical schools, we note that the order for the North Atlantic division is *Massachusetts Institute of Technology, Dartmouth, Lehigh, Williams, Amherst, Wesleyan, Bowdoin, Purdue.* *Wesleyan* naturally leads in Connecticut, *Bowdoin* in Maine, *Massachusetts Institute of Technology* in Massachusetts, *Dartmouth* in New Hampshire and Vermont and *Lehigh* in New Jersey and Pennsylvania. *Williams* leads in New York state and *Massachusetts Institute of Technology* in Rhode Island. 27 per cent. of the students at *Amherst,* as against 43 per cent. in 1906, have their permanent home in Massachusetts; *Bowdoin* attracts 74 per cent. of its student body from Maine, as against 77 per cent. in 1908; 27 per cent. of *Dartmouth's* students, as against 21 per cent. in 1906, hail from New Hampshire and Vermont; the *Massachusetts Institute of Technology* attracts 56 per cent. of its student body from Massachusetts, as against 55 per cent. in 1908; 20 per cent. of *Wesleyan's* students, as against 35 per cent. in 1908, claim Connecticut as their permanent home, while *Williams* enrolls 22 per cent. of its student body from Massachusetts. The latter institution attracts almost twice as many students from New York as from Massachusetts; *Amherst* also attracts more students from the Empire state than from Massachusetts, and *Dartmouth* attracts almost twice as many from Massachusetts as from New Hampshire. 56 per cent. of *Lehigh's* student body hail from Pennsylvania, as against 60 per cent. in 1906, while 76 per cent. of *Purdue's* students claim Indiana as their permanent residence, this figure having remained stationary since 1908.

Of the eastern universities, *Syracuse* possesses the largest percentage of enrollment from its own state, namely, 86 per cent; it is followed by *Pennsylvania* with an enrollment of 67 per cent. from its own state, the same as in 1906. *Columbia's* percentage of New York students has dropped from 66 per cent. in 1906 to 62 per cent. in 1911; *Virginia* attracts 57 per cent. of its clientele from its own state, as against 53 per cent. in 1908; *Cornell's* percentage of New York students has dropped from 56 per cent. in 1906 to 55 per cent. in 1911; of *Harvard's* students 50 per cent., as against 54 per cent. in 1906, are residents of Massachusetts; of the students of *Johns Hopkins* 41 per cent. are residents of Maryland, as against 43 per cent. in 1909; of *Yale's* students 35 per cent., as against 33 per cent. in 1906, have their home in Connecticut; and of *Princeton's* student body only 21 per cent., as against 20 per cent. in 1906, are residents of the state of New Jersey.

Coming to the South Atlantic division and taking into consideration only the six eastern universities mentioned in the beginning of the article, we note that the order is *Pennsylvania, Cornell, Columbia, Harvard, Princeton* and *Yale*—*Pennsylvania* and *Cornell,* and *Princeton* and *Yale* having changed places since 1905. Of the remaining eastern universities *Virginia* and *Johns Hopkins* naturally have the largest following in this division, while of the western institutions only *Michigan* makes a good showing here. Of the colleges *Lehigh* has the best representation, its main strength lying in Maryland. As for the standing in individual states, *Pennsylvania* naturally leads in Delaware and *Johns Hopkins* in Maryland; *Cornell* leads in the District of Columbia, *Pennsylvania* in Florida and North Carolina, *Columbia* in Georgia and South Carolina and *Ohio State* in West Virginia. *Princeton* is second in Delaware, *Cornell* in Maryland and *Johns Hopkins* in Virginia.

In the South Central division *Texas* naturally heads the list, followed by *Columbia* (133, as against 72 in 1905), *Virginia* (127), *Harvard* (113–88), *Michigan* (97–64), *Cornell* (91–76), *Yale* (90–80) and *Missouri. Purdue, Massachusetts Institute of Technology* and *Wellesley* draw over 30 students each from this division. The largest representation from individual states is found at the following universities. Alabama: *Columbia, Harvard* and *Virginia;* Arkansas: *Missouri, Northwestern;* Kentucky: *Michigan, Harvard* and *Princeton* and *Yale;* Louisiana: *Virginia, Cornell* and *Johns Hopkins;* Mississippi: *Columbia, Virginia;* Oklahoma: *Missouri, Kansas, Michigan;* Tennessee: *Columbia, Cornell* and *Virginia;* and Texas: *Texas, Virginia, Columbia* and *Harvard* and *Yale.*

In the North Central division the order for the institutions located in that region is *Minnesota, Nebraska, Wisconsin, Illinois, Michigan, Northwestern, Ohio State, Missouri, Indiana, Kansas, Iowa, Purdue, Washington.* All of these of course have a larger patronage in this division than any of the eastern universities, which come in the order *Harvard, Cornell, Yale, Columbia, Pennsylvania, Princeton, Johns Hopkins, Syracuse, Virginia.* Since 1905 *Cornell* and *Yale,* and *Pennsylvania* and *Princeton* have exchanged places. *Columbia's* representation in this group of states has grown from 262 to 514 in six years, *Cornell's* from 381 to 556, *Harvard's* from 526 to 658, *Pennsylvania's* from 139 to 203, *Yale's* from 506 to 523, while *Princeton's* has dropped from 209 to 190. Leaving the state institutions out of consideration in each case, *Wisconsin* is seen to have the largest following in Illinois, being followed by *Michigan, Cornell, Yale, Harvard, Smith. Illinois* leads in Indiana, and is followed in that state by *Northwestern, Michigan, Columbia, Wisconsin, Harvard, Cornell.* In Iowa the order is *Northwestern, Wisconsin, Illinois, Nebraska, Michigan, Harvard;* in Kansas: *Northwestern, Michigan, Illinois, Harvard, Columbia, Yale;* in Michigan: *Northwestern, Wisconsin, Columbia, Illinois, Harvard, Yale;* in Minnesota: *Northwestern,*

1910–1911	California	Columbia	Cornell	Harvard	Illinois	Indiana	Iowa	Johns Hopkins	Kansas	Michigan	Minnesota	Missouri	Nebraska	Northwestern	Ohio State	Pennsylvania	Princeton	Stanford
North Atlantic Division	*34*	*4679*	*3194*	*3421*	*76*	*8*	*10*	*142*	*7*	*638*	*9*	*21*	*8*	*64*	*86*	*4272*	*997*	*49*
Connecticut	....	95	67	64	2	2	....	17	....	15	....	....	....	2	2	40	15	1
Maine	1	33	12	102	2	....	....	5	....	8	3	....	....	2	....	21	2	2
Massachusetts	8	86	102	2364	15	....	1	13	....	35	2	4	1	3	7	56	29	5
New Hampshire	1	10	11	57	3	....	....	3	....	3	....	....	....	1	....	18	2	....
New Jersey	3	569	224	69	6	2	....	7	1	23	....	1	2	1	6	437	305	3
New York	10	3676	2421	491	29	2	5	39	3	371	2	10	3	27	40	271	346	25
Pennsylvania	9	175	339	181	15	2	4	52	1	168	1	6	2	24	30	3411	289	10
Rhode Island	1	16	3	76	4	....	....	2	....	3	1	....	....	2	....	10	7	1
Vermont	1	19	15	27	....	....	....	4	2	12	....	....	....	2	1	8	2	2
South Atlantic Division	*8*	*210*	*238*	*147*	*18*	*3*	....	*461*	*4*	*72*	*3*	*10*	*3*	*19*	*32*	*243*	*133*	*4*
Delaware	....	4	11	5	....	....	....	....	....	1	....	....	....	2	....	53	21	....
Dist. of Columbia	2	14	47	34	3	2	....	13	....	40	....	2	....	2	3	30	24	3
Florida	1	7	7	3	1	1	....	3	1	3	....	3	1	2	....	10	7	....
Georgia	1	36	11	20	2	....	....	23	....	6	....	2	....	4	1	15	6	....
Maryland	2	38	94	29	1	....	....	337	....	11	....	....	....	....	1	59	46	1
North Carolina	....	26	18	15	2	....	....	18	1	2	2	1	1	1	....	28	8	....
South Carolina	2	30	9	13	4	....	....	7	....	4	....	1	....	1	1	14	1	....
Virginia	....	46	27	17	2	....	....	49	2	2	1	1	1	4	3	22	11	....
West Virginia	....	10	14	11	3	....	....	11	....	3	....	....	....	3	23	12	9	....
South Central Division	*17*	*133*	*91*	*113*	*73*	*30*	*6*	*54*	*38*	*97*	*2*	*89*	*8*	*72*	*23*	*57*	*70*	*13*
Alabama	2	28	10	23	5	....	....	9	....	12	....	2	....	3	....	14	8	1
Arkansas	....	4	8	10	10	2	....	4	....	7	....	19	2	12	1	2	2	1
Kentucky	6	19	13	23	12	22	2	17	1	31	....	6	....	9	13	14	23	2
Louisiana	....	6	7	6	6	....	2	7	....	4	....	2	1	3	1	5	6	....
Mississippi	1	19	5	8	9	....	....	2	....	2	....	4	....	9	1	2	2	1
Oklahoma	1	7	7	4	11	2	1	....	34	16	....	39	2	14	2	....	....	3
Tennessee	....	27	19	16	10	3	....	4	....	10	1	2	2	11	....	9	16	2
Texas	7	23	22	23	10	1	1	11	3	15	1	15	1	11	5	11	13	3
North Central Division	*117*	*514*	*666*	*668*	*4188*	*2383*	*2024*	*106*	*2323*	*3599*	*6593*	*2662*	*4548*	*3457*	*2611*	*203*	*190*	*114*
Illinois	23	71	136	117	3535	12	30	19	5	241	16	50	1	2361	7	14	51	26
Indiana	12	63	50	68	182	2343	5	11	1	163	3	17	2	166	18	33	18	11
Iowa	12	41	29	58	104	....	1903	10	7	60	53	23	76	256	8	21	10	25
Kansas	5	30	10	31	37	1	4	4	2131	41	4	9	24	56	2	8	2	12
Michigan	14	54	35	40	51	2	3	1	1	2541	1	5	2	83	8	9	16	2
Minnesota	16	37	24	42	40	1	22	5	....	36	6326	....	7	74	1	19	14	5
Missouri	8	49	46	56	75	3	16	13	178	54	1	2430	17	69	3	19	27	8
Nebraska	11	16	16	24	18	....	10	4	....	34	4	7	4398	55	1	8	4	4
North Dakota	3	3	5	9	12	1	5	3	....	9	69	1	....	30	....	1	1	2
Ohio	7	107	172	174	44	17	2	17	....	350	1	12	3	75	2559	52	44	12
South Dakota	2	4	9	14	23	....	20	4	....	26	44	6	16	58	2	2	....	3
Wisconsin	4	39	25	35	67	3	4	14	....	44	71	2	3	175	2	17	3	4
Western Division	*4077*	*162*	*119*	*186*	*89*	*3*	*22*	*32*	*19*	*229*	*24*	*33*	*49*	*149*	*24*	*71*	*31*	*1627*
Arizona	10	5	....	....	....	....	....	....	....	5	1	2	1	6	....	2	....	9
California	3867	55	32	65	12	....	5	14	3	45	2	5	5	18	3	20	5	1371
Colorado	17	23	28	32	23	....	9	....	9	50	2	6	17	24	2	10	10	20
Idaho	16	2	....	4	8	....	4	1	1	7	....	2	2	3	2	3	....	7
Montana	9	10	5	13	10	....	1	....	1	43	15	5	6	22	2	2	1	16
Nevada	11	1	....	3	....	....	....	....	....	6	....	....	1	1	....	1	....	7
New Mexico	4	2	....	2	2	1	....	2	4	11	....	8	....	1	....	1	....	4
Oregon	69	14	10	17	3	....	1	6	....	21	....	....	4	14	....	6	6	31
Utah	18	12	20	15	5	1	....	1	1	9	....	....	1	33	14	6	1	17
Washington	54	26	23	31	21	1	2	7	....	26	4	1	....	24	....	19	7	42
Wyoming	2	2	1	4	5	....	....	1	....	6	....	4	12	3	1	1	1	3
Insular and Non-contiguous Ter.	*29*	*14*	*48*	*17*	*12*	....	*2*	*1*	....	*16*	....	*3*	....	*5*	*3*	*23*	....	*15*
Alaska	3	1	1	....	....	....	....	....	....	....	....	....	....	....	....	....	....	1
Canal Zone	....	....	....	1	....	....	....	....	....	....	....	....	....	2	....	....	....	....
Hawaiian Islands	19	5	12	9	3	....	....	....	....	2	....	2	....	1	....	....	....	14
Philippine Islands	7	....	13	3	6	....	1	....	....	4	....	1	....	2	1	2	....	....
Porto Rico	....	8	22	4	3	....	1	1	....	10	....	....	....	....	2	21	....	....
Total	4282	5702	4246	4542	4456	2427	2064	795	2391	4651	5631	2718	4616	3766	2779	4869	1421	1722

1910–1911	Syracuse	Texas	Virginia	Washington	Wisconsin	Yale	Amherst	Bowdoin	Dartmouth	Lehigh	Mass. Inst. Tech.	Purdue	Wesleyan	Williams	Bryn Mawr	Mt. Holyoke	Smith	Vassar	Wellesley
North Atlantic Division	*3111*	*4*	*37*	*7*	*96*	*2342*	*404*	*324*	*1037*	*496*	*1118*	*59*	*331*	*433*	*259*	*671*	*1147*	*701*	*1000*
Connecticut	28	....	1	1	3	1138	20	4	24	6	33	3	73	21	8	89	118	62	53
Maine	4	....	....	....	3	26	5	251	44	1	24	....	21	9	1	32	39	7	43
Massachusetts	37	1	4	2	16	213	138	51	449	14	840	2	44	118	27	258	383	101	403
New Hampshire	11	....	....	....	2	14	2	9	243	....	27	1	5	1	3	38	44	9	24
New Jersey	53	....	9	....	13	135	41	....	25	63	18	13	48	46	20	47	142	73	92
New York	2794	2	13	2	40	572	153	7	132	46	106	24	100	211	61	146	277	362	211
Pennsylvania	148	1	10	2	16	194	27	....	14	360	37	16	32	12	134	30	90	82	134
Rhode Island	3	....	....	....	2	21	8	1	16	6	27	....	3	9	5	12	24	9	22
Vermont	33	....	....	....	1	29	10	1	91	....	6	....	4	6	....	19	30	6	18
South Atlantic Division	*33*	*3*	*508*	*3*	*26*	*97*	*4*	....	*24*	*93*	*41*	*12*	*11*	*6*	*36*	*7*	*31*	*27*	*29*
Delaware	6	....	2	....	....	9	....	....	1	4	....	1	....	....	4	1	5	4	2
Dist. of Columbia	11	....	12	....	6	17	2	....	15	14	5	3	6	2	2	2	8	4	10
Florida	3	....	8	1	1	6	1	....	2	1	1	2	....	....	....	....	1	4	3
Georgia	3	1	8	....	....	11	....	....	....	....	5	....	1	....	1	1	5	3	1
Maryland	3	....	20	1	5	13	1	....	3	56	14	2	3	2	24	....	4	2	4
North Carolina	2	....	22	....	2	12	....	....	....	7	....	....	1	1	1	1	2	2	5
South Carolina	....	....	10	....	7	4	....	....	....	1	1	....	....	....	....	....	1	....	....
Virginia	4	2	410	1	3	14	....	....	1	4	12	2	....	....	4	....	3	8	2
West Virginia	1	....	10	....	2	11	....	....	2	6	3	2	....	....	....	2	2	....	2
South Central Division	*7*	*1908*	*127*	*26*	*43*	*90*	*1*	....	*7*	*8*	*37*	*58*	*6*	*1*	*13*	*7*	*20*	*29*	*36*
Alabama	....	1	23	....	2	9	....	....	....	1	4	2	1	....	2	....	2	1	1
Arkansas	3	5	9	9	2	4	....	....	1	....	2	5	....	....	1	....	2	3	3
Kentucky	2	....	18	3	12	23	....	....	2	1	2	35	1	....	1	5	3	6	17
Louisiana	....	5	11	3	2	5	....	....	....	....	5	....	....	....	1	....	....	1	1
Mississippi	....	1	17	....	....	7	....	....	....	2	6	3	....	....	3	....	3	....	1
Oklahoma	1	9	4	3	8	3	....	....	....	....	....	1	....	....	....	1	....	2	....
Tennessee	....	4	19	4	6	16	1	....	1	1	5	7	2	1	1	1	5	8	7
Texas	1	1883	26	4	11	23	....	....	3	3	13	5	2	....	4	....	5	6	6
North Central Division	*42*	*19*	*30*	*1028*	*4376*	*623*	*70*	*8*	*136*	*12*	*140*	*1444*	*13*	*90*	*93*	*54*	*368*	*282*	*245*
Illinois	4	5	5	87	395	127	23	1	62	2	33	52	2	30	46	10	113	65	57
Indiana	1	....	1	4	62	39	1	....	2	1	10	1228	3	4	7	4	17	20	13
Iowa	1	5	....	9	133	30	3	....	13	....	4	7	2	1	2	4	19	11	18
Kansas	3	3	....	10	21	25	1	....	1	....	9	4	....	1	6	3	13	2	7
Michigan	7	....	2	1	55	39	6	2	10	3	9	20	3	3	3	7	34	34	20
Minnesota	6	....	2	1	47	41	4	1	8	1	8	8	....	16	2	2	35	14	25
Missouri	5	5	11	907	28	58	4	....	....	2	13	12	....	1	8	....	22	23	24
Nebraska	1	....	....	1	11	11	7	1	3	....	6	8	....	1	3	3	12	5	10
North Dakota	1	....	....	....	22	3	....	....	1	....	3	....	....	....	....	....	....	2	....
Ohio	8	....	8	3	40	136	18	1	32	2	33	95	3	27	11	14	80	58	52
South Dakota	1	....	1	1	47	2	....	1	4	....	3	7	....	1	....	2	3	....	7
Wisconsin	4	1	....	4	3514	12	3	1	....	1	9	3	....	5	5	5	18	28	12
Western Division	*10*	*5*	*15*	*3*	*74*	*130*	*17*	*4*	*18*	*8*	*63*	*23*	*1*	*11*	*5*	*9*	*42*	*31*	*56*
Arizona	1	....	....	....	2	3	....	....	1	....	1	1	....	....	....	....	1	1	2
California	1	....	7	2	13	40	1	2	3	1	21	7	....	1	1	5	6	14	15
Colorado	1	2	1	1	10	27	4	....	8	2	9	4	1	3	1	....	10	6	15
Idaho	2	....	2	....	5	2	....	....	....	....	....	1	....	....	....	1	....	1	....
Montana	4	....	2	....	25	6	1	....	3	....	2	4	....	....	....	1	1	4	4
Nevada	....	....	....	....	....	1	....	....	....	....	....	....	....	....	....	....	....	....	1
New Mexico	....	3	2	....	1	4	....	....	....	2	....	....	....	....	....	....	2	....	1
Oregon	1	....	....	....	4	14	7	....	....	....	8	....	....	2	3	....	5	....	5
Utah	....	....	....	....	3	7	2	....	....	1	3	3	....	....	....	....	3	2	3
Washington	....	....	1	....	10	25	2	2	3	2	9	3	....	5	....	2	14	3	9
Wyoming	....	....	....	....	1	1	....	....	....	....	....	....	....	....	....	....	....	....	1
Insular and Non-contiguous Ter.	*15*	....	*5*	....	*6*	*11*	....	....	*1*	*2*	*16*	*4*	*1*	....	*1*	....	*2*	*2*	*4*
Alaska	....	....	....	....	....	1	....	....	....	....	....	....	....	....	....	....	....	....	....
Canal Zone	....	....	2	....	....	1	....	....	....	....	1	....	....	....	....	....	....	....	....
Hawaiian Islands	....	....	....	....	1	6	....	....	....	....	2	....	....	....	1	....	....	....	3
Philippine Islands	....	....	....	....	3	1	....	....	....	....	4	3	....	....	....	....	2	1	....
Porto Rico	15	....	3	....	2	2	....	....	1	2	8	1	1	....	....	....	....	1	1
Total	3218	1939	722	1067	4620	3193	496	336	1223	618	1404	1600	363	540	407	748	1608	1062	1370

Foreign Countries	California	Columbia	Cornell	Harvard	Illinois	Indiana	Iowa	Johns Hopkins	Kansas	Michigan	Minnesota	Missouri	Nebraska	Northwestern	Ohio State	Pennsylvania
North America	*16*	*67*	*49*	*60*	*31*	....	*2*	*11*	*4*	*34*	*3*	*10*	*3*	*41*	*4*	*62*
Canada	9	53	16	52	17	....	....	10	2	25	3	3	3	35	2	21
Central America	....	2	7	2	....	....	....	....	....	....	....	....	....	....	....	13
Cuba	....	3	17	2	1	....	1	....	1	1	....	2	....	....	2	10
Mexico	7	8	7	3	13	....	1	1	1	5	....	5	....	4	....	11
Newfoundland	....	....	1	....	....	....	....	....	....	....	....	....	....	....	....	....
West Indies	....	1	1	1	....	....	....	....	....	3	....	....	....	2	....	7
South America	*4*	*2*	*23*	*4*	*6*	....	....	....	....	*10*	....	*2*	*1*	*4*	*6*	*38*
Argentine Rep.	1	....	8	1	2	....	....	....	....	3	....	....	1	3	5	}
Brazil	....	1	2	....	....	....	....	....	....	2	....	....	....	....	....	}
British Guiana	....	....	....	....	3	....	....	....	....	1	....	....	....	1	....	}
Chili	3	1	1	....	....	....	....	....	....	....	....	....	....	....	....	}
Colombia	....	....	....	1	....	....	....	....	....	2	....	....	....	....	....	}38
Dutch Guiana	....	....	....	1	....	....	....	....	....	....	....	....	....	....	....	}
Ecuador	....	....	3	....	....	....	....	....	....	....	....	....	....	....	....	}
Paraguay	....	....	6	....	1	....	....	....	....	....	....	....	....	....	1	}
Peru	....	....	2	1	....	....	....	....	....	2	....	2	....	....	....	}
Uruguay	....	....	1	....	....	....	....	....	....	....	....	....	....	....	....	....
Europe	*18*	*43*	*21*	*43*	*31*	....	*4*	*4*	*2*	*14*	....	*5*	*1*	*25*	*7*	*62*
Austria-Hungary	1	....	....	2	4	....	....	....	....	....	....	....	....	1	1	1
Belgium	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....
Bulgaria	....	1	....	2	....	....	....	....	....	....	....	1	....	....	....	....
Denmark	1	1	1	1	....	....	....	....	....	....	....	1	....	1	....	6
France	1	5	4	5	....	....	....	2	....	....	....	....	....	....	....	9
Germany	3	12	2	8	1	....	1	....	....	3	....	1	....	3	....	8
Great Britain and Ireland	4	9	2	8	9	....	....	....	....	3	....	....	....	4	....	11
Greece	....	....	1	....	....	....	....	....	....	....	....	....	....	1	....	....
Holland	1	3	....	1	2	....	....	....	1	2	....	....	....	....	....	3
Italy	....	....	....	3	....	....	....	....	....	....	....	....	....	....	....	8
Norway	....	....	1	....	1	....	....	....	....	....	....	....	....	2	....	....
Rumania	1	....	....	....	....	....	....	1	....	....	....	....	....	....	....	....
Russia	5	2	3	5	10	....	....	....	1	2	....	2	....	6	3	....
Spain	....	1	....	1	....	....	....	....	....	....	....	....	....	....	....	2
Sweden	....	1	1	1	1	....	....	....	....	....	....	....	....	7	....	2
Switzerland	....	1	1	1	....	....	....	....	....	1	....	....	1	....	....	1
Turkey	1	7	5	5	3	....	3	1	....	3	....	....	....	....	3	1
Asia	*92*	*74*	*58*	*44*	*63*	*4*	*10*	*4*	....	*38*	*3*	*5*	*3*	*26*	*6*	*31*
China	24	39	51	24	39	2	1	1	....	26	....	3	....	2	1	20
Corea	....	....	....	....	....	....	....	....	....	....	....	....	1	2	....	1
India	11	6	1	9	6	....	3	....	....	6	....	2	....	8	1	1
Japan	55	27	6	8	17	2	6	2	....	5	3	....	2	8	3	7
Persia	....	1	....	....	....	....	....	1	....	....	....	....	....	1	....	....
Siam	....	....	....	1	....	....	....	....	....	....	....	....	....	....	....	....
Straits Settlements	....	....	....	....	....	....	....	....	....	....	....	....	....	1	....	....
Turkey	2	1	....	2	6	....	....	....	....	1	....	....	....	4	1	2
Africa	*2*	*2*	*7*	*2*	*1*	....	....	....	....	*2*	*1*	....	....	*4*	*1*	*4*
Egypt	....	....	1	1	1	....	....	....	....	....	....	....	....	1	....	4
South Africa	2	2	6	1	....	....	....	....	....	2	1	....	....	3	1	....
Australasia	*5*	*3*	*3*	*1*	*1*	....	....	*1*	....	*2*	....	*1*	....	*8*	....	*18*
Australia	3	3	3	....	1	....	....	1	....	1	....	1	....	8	....	18
New Zealand	2	....	....	1	....	....	....	....	....	1	....	....	....	....	....	....
Total (Foreign Countries)	137	191	161	154	138	4	16	20	6	100	7	23	8	108	24	205
Total (United States)	4282	5702	4246	4642	4456	2427	2064	795	2391	4651	5631	2718	4616	3766	2779	4869
Grand Total	4419	5893	4407	4696	4594	2431	2080	815	2397	4751	5638	2741	4624	3874	2803	5074

Foreign Countries	Princeton	Stanford	Syracuse	Texas	Virginia	Washington	Wisconsin	Yale	Amherst	Bowdoin	Dartmouth	Lehigh	Mass. Inst. Tech.	Purdue	Wesleyan	Williams	Bryn Mawr	Mt. Holyoke	Smith	Vassar	Wellesley
North America	*8*	*7*	*14*	....	....	*3*	*18*	*31*	....	*1*	....	*13*	*37*	*4*	*1*	*1*	*4*	*2*	....	*3*	*4*
Canada	7	4	7	....	....	2	12	30	....	1	....	....	18	....	1	....	4	....	....	3	4
Central America	....	....	....	....	....	....	....	....	....	....	....	3	4	....	....	....	....	....	....	....	....
Cuba	....	....	7	....	....	....	1	1	....	....	....	6	5	2	....	....	....	....	....	....	....
Mexico	....	3	....	....	....	1	5	....	....	....	....	4	9	2	....	1	....	2	....	....	....
Newfoundland	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....
West Indies	1	....	....	....	....	....	....	....	....	....	....	....	1	....	....	....	....	....	....	....	....
South America	*1*	*1*	*7*	....	*1*	....	*2*	*1*	....	....	....	*3*	*14*	*2*	....	....	....	....	....	....	....
Argentine Rep.	....	....	1	....	....	....	....	....	....	....	....	....	5	....	....	....	....	....	....	....	....
Brazil	1	....	3	....	....	....	1	....	....	....	....	2	2	2	....	....	....	....	....	....	....
British Guiana	....	....	....	....	....	....	....	1	....	....	....	....	....	....	....	....	....	....	....	....	....
Chili	....	1	1	....	....	....	....	....	....	....	....	....	3	....	....	....	....	....	....	....	....
Colombia	....	....	....	....	1	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....
Dutch Guiana	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....
Ecuador	....	....	....	....	....	....	....	....	....	....	....	1	1	....	....	....	....	....	....	....	....
Paraguay	....	....	....	....	....	....	....	....	....	....	....	....	1	....	....	....	....	....	....	....	....
Peru	....	....	2	....	....	....	1	....	....	....	....	....	2	....	....	....	....	....	....	....	....
Uruguay	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....
Europe	*3*	*6*	*6*	....	....	*5*	*14*	*14*	*1*	*1*	*1*	....	*11*	*3*	*3*	....	*11*	....	....	*1*	*1*
Austria-Hungary	....	1	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....
Belgium	....	....	....	....	....	....	1	....	....	....	....	....	....	....	....	....	....	....	....	....	....
Bulgaria	....	....	....	....	....	1	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....
Denmark	....	....	....	....	....	....	....	....	....	....	....	....	1	....	....	....	....	....	....	....	....
France	1	....	....	....	....	....	2	....	1	....	1	....	2	....	....	....	1	....	....	....	....
Germany	....	....	1	....	....	....	1	2	....	....	....	....	1	....	....	....	1	....	....	....	....
Great Britain and Ireland	2	2	1	....	....	....	....	6	....	....	....	....	1	....	1	....	9	....	....	....	....
Greece	....	....	....	....	....	1	....	1	....	....	....	....	....	1	....	....	....	....	....	....	....
Holland	....	2	1	....	....	....	1	1	....	....	....	....	....	....	....	....	....	....	....	....	....
Italy	....	....	....	....	....	1	....	2	....	....	....	....	1	1	2	....	....	....	....	1	....
Norway	....	....	....	....	....	....	1	1	....	....	....	....	1	....	....	....	....	....	....	....	....
Rumania	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....
Russia	....	....	1	....	....	1	3	....	....	....	....	....	3	....	....	....	....	....	....	....	1
Spain	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....
Sweden	....	....	1	....	....	....	1	1	....	....	....	....	....	....	....	....	....	....	....	....	....
Switzerland	....	1	....	....	....	....	....	....	....	....	....	....	1	1	....	....	....	....	....	....	....
Turkey	....	....	1	....	....	1	4	....	....	1	....	....	....	....	....	....	....	....	....	....	....
Asia	*6*	*14*	*11*	....	*1*	....	*61*	*43*	*5*	....	*3*	*6*	*34*	*3*	....	*1*	*3*	*4*	....	*6*	*5*
China	1	2	4	....	1	....	30	16	1	....	3	6	27	3	....	....	....	....	....	....	3
Corea	....	....	....	....	....	....	....	1	....	....	....	....	....	....	....	....	....	....	....	....	....
India	1	3	2	....	....	....	4	4	2	....	....	....	....	....	....	....	....	2	....	1	....
Japan	2	9	4	....	....	....	16	6	2	....	....	....	4	....	....	....	2	....	....	....	1
Persia	....	....	1	....	....	....	1	....	....	....	....	....	....	....	....	1	....	....	....	3	1
Siam	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....
Straits Settlements	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....
Turkey	2	....	....	....	....	....	....	16	....	....	....	....	3	....	....	....	1	2	....	2	....
Africa	*3*	....	....	....	....	....	*3*	....	....	....	*2*	....	*3*	....	....	....	....	....	....	....	....
Egypt	1	....	....	....	....	....	....	....	....	....	2	....	1	....	....	....	....	....	....	....	....
South Africa	2	....	....	....	....	....	3	....	....	....	....	....	2	....	....	....	....	....	....	....	....
Australasia	....	*5*	....	....	....	....	*1*	....	....	....	....	....	*3*	....	....	....	....	....	....	....	....
Australia	....	5	....	....	....	....	1	....	....	....	....	....	2	....	....	....	....	....	....	....	....
New Zealand	....	....	....	....	....	....	....	....	....	....	....	....	1	....	....	....	....	....	....	....	....
Total (Foreign Countries)	21	33	38	0	2	8	89	89	6	2	6	22	102	12	4	2	18	6	0	10	10
Total (United States)	1421	1722	3218	1939	722	1067	4620	3193	496	336	1223	618	1464	1600	363	540	407	748	1608	1062	1370
Grand Total	1442	1755	3256	1939	724	1075	4709	3282	502	338	1229	640	1506	1612	367	542	425	784	1608	1062	1380

Wisconsin, Harvard, Yale, Illinois, Columbia, Michigan; in Missouri: *Kansas, Illinois, Northwestern, Yale, Harvard, Michigan, Columbia, Cornell;* in Nebraska: *Northwestern, Michigan, Harvard, Illinois, Columbia* and *Cornell;* in North Dakota: *Minnesota, Northwestern, Wisconsin, Illinois, Harvard* and *Michigan;* in Ohio: *Michigan, Harvard, Cornell, Yale, Columbia, Purdue, Smith;* in South Dakota: *Northwestern, Wisconsin, Minnesota, Michigan, Illinois, Iowa;* in Wisconsin: *Northwestern, Minnesota, Illinois, Michigan, Columbia, Harvard, Vassar.* It will thus be seen that *Northwestern* is mentioned as first in no less than seven of the twelve states included in this division. Of the male colleges and technical schools the order is *Purdue, Massachusetts Institute of Technology, Dartmouth, Williams, Amherst;* of the girls' colleges *Smith, Vassar, Wellesley, Bryn Mawr, Mount Holyoke,* the first three mentioned all having a larger representation from this division than either *Pennsylvania* or *Princeton.*

In the Western division (leaving *California* and *Stanford* out of consideration), *Michigan* is still in the lead, with *Harvard, Columbia, Northwestern, Yale* and *Cornell,* each of which attracts over one hundred students from this division, following. *Michigan's* representation has grown from 134 to 229 since 1905; *Harvard's* from 126 to 186; *Columbia's* from 111 to 152; *Yale's* from 78 to 130; *Cornell's* from 76 to 119; *Illinois's* from 41 to 89; *Pennsylvania's* from 22 to 71; while *Princeton's* has dropped from 41 to 31. *Northwestern* leads in Arizona; *Illinois* in Idaho; *Michigan* in Nevada and New Mexico; *Nebraska* in Wyoming. In California the order is *Harvard, Columbia, Michigan, Yale;* in Colorado: *Michigan, Harvard, Cornell, Yale;* in Montana: *Michigan, Wisconsin, Northwestern, Minnesota;* in Oregon: *Michigan, Harvard, Columbia* and *Northwestern* and *Yale;* in Utah: *Northwestern, Cornell, Harvard, Columbia;* in Washington: *Harvard, Columbia* and *Michigan, Yale.*

Taking only the six eastern universities mentioned at the beginning of the article into consideration, and counting ties in fractions, we find that *Harvard* leads in $20\frac{2}{3}$ states of the Union, *Columbia* in $12\frac{5}{6}$, *Cornell* in $6\frac{1}{2}$, *Yale* in $4\frac{2}{3}$, *Pennsylvania* in 4 and *Princeton* in $\frac{1}{3}$.

Cornell maintains its lead in the number of students from insular and non-contiguous territories, being followed by *California* and *Pennsylvania. California* leads in Alaska and the Hawaiian Islands, *Cornell* in the Philippines and Porto Rico and *Northwestern* and *Virginia* in the Canal Zone.

The number of foreign students at American institutions of higher learning continues to show a noteworthy increase. There are enrolled at the group of six eastern universities mentioned at the beginning of the article 821 foreigners, as against 540 in 1905. At the twenty-one universities represented in the tables for 1908–9 and 1910–11 there were in attendance 1,296 foreigners in the former year as against 1,536 in the latter. At the twelve universities represented in the tables for 1906–7 and 1910–11 there were in attendance 898 students from foreign countries in the former year, as against 1,311 in the latter. Adding the foreign clientele of the colleges and technical schools in the table, we find that thirty-seven American institutions attracted no less than 1,782 foreigners during the academic year 1910–11, this figure being, as all the other comparisons have been, exclusive of the summer session attendance. In 1908–9 thirty-four of these institutions attracted 1,467 foreigners, while the same institutions in 1910–11 had a foreign enrollment of 1,736 students. Taking the representation of foreigners at all of the thirty-seven institutions included in the table, we find that the largest delegations have been sent by the following countries: Canada 344, China 330, Japan 197, Mexico 193, Turkey (in Europe and Asia) 84, India 73, Great Britain and Ireland 72, Cuba 62, Germany 48, Russia 48 and Australia 47. Omitting the foreigners of the three institutions not included in the table for 1908–9 and comparing the foreign enrollment for the year mentioned with that of 1910–11, we secure the following results, the first figure mentioned in each case being that for 1911, the second that for 1909: Canada 335–242, China 326–193, Japan 193–158, Mexico 92–81, Turkey 82–51, India 71–60, Great Britain and Ireland 71–71, Cuba 55–70, Germany 47–56, Russia 46–50 and Australia 47–43. Owing to the fact that *Pennsylvania* did not separate the students from South America into the individual countries from which they hailed, it is impossible to determine whether the Argentine Republic should be included in the above list of countries with a representation of 46 or over. 548 of the 1,782 foreigners at the thirty-seven institutions in the present table hailed from North America, 132 from South America, 351 from Europe, 662 from Asia, 37 from Africa and 52 from Australasia. Omitting the three institutions (*Syracuse, Texas* and *Washington*) not included in the table for 1909 and comparing the figures for the two years in question, we find that between 1909 and 1911 the representation from North America increased from 460 to 531, that from Europe from 313 to 340, that from Asia from 458 to 651, that from Africa from 18 to 37, while that from South America decreased from 154 to 125, and that from Australasia from 64 to 52, the largest increase thus having taken place in Asia.

If we compare the foreign clientele of twenty-one of the leading American universities,[1] with that of the twenty-one German universities, we find that America is still far behind Germany in the matter of attracting foreign students to its higher institutions of learning. During the winter semester of 1910–11, the twenty-one German universities attracted altogether no less than 4,672 students from foreign countries, as against 1,576 foreigners at the American universities mentioned. The latter figure would no doubt be slightly increased in case the University of *Chicago,* for which geographical distribution figures are unfortunately not available, were substituted for one of the smaller middle western universities. The German universities draw 4,046 students from other European countries, 398 from North and South America, 203 from Asia, 20 from Africa and 5 from Australasia, while the American universities attract 478 students from North American countries outside of the United States, 112 from South America, 318 from Europe, 587 from Asia, 32 from Africa and 49 from Australasia, in other words, the American universities lead in every continent with the exception of Europe. Almost half of the European foreigners at German universities hail from Russia, namely, 1,998 out of 4,046, this country being followed by Austria-Hungary with 760, Switzerland with 353, Bulgaria with 159, Great Britain and Ireland with 142, Rumania with 137, Greece with 83, Servia with 78, Luxemburg with 61 and Turkey with 57, the remaining countries

[1] California, Columbia, Cornell, Harvard, Illinois, Iowa, Johns Hopkins, Kansas, Michigan, Minnesota, Missouri, Nebraska, Northwestern, Ohio State, Pennsylvania, Princeton, Stanford, Syracuse, Washington, Wisconsin, Yale.

sending less than fifty students each. Among European countries the twenty-one universities of the United States lead only in Denmark (12 *vs.* 11), the American figures in European countries mentioned above being in every case far below the German figures, namely Russia 44, Austria-Hungary 11, Switzerland 7, Bulgaria 5, Great Britain and Ireland 61, Rumania 2, Greece 4, Servia and Luxemburg 0 and Turkey 38. Almost a third of the foreign students in attendance on German universities are at the University of *Berlin*, namely, 1,492 out of 4,672. *Berlin* is followed by the following universities in the order given: *Munich* 845, *Leipzig* 634, *Halle* 285, *Heidelberg* 186, *Königsberg* 185 (of whom 179 hail from Russia), *Göttingen* 141, *Freiburg* 127, *Jena* 119, *Bonn* 117, *Breslau* 107, *Strassburg* 105, the remaining institutions all attracting less than one hundred foreigners each. Figured on a percentage basis we find that 8.5 per cent. of Germany's 54,823 university students are foreigners, whereas only 2.1 per cent. of 74,325 students attending the twenty-one American universities mentioned hail from foreign countries. It should be borne in mind that the American institutions in every instance include an undergraduate academic department and in most instances a technical school, which is not the case for the German universities, but the comparison here outlined undoubtedly conveys a fairly accurate idea of the situation.

Of the three middle western universities that were included in the table for 1904–5, *Illinois* shows a gain in students from foreign countries during the six years of 120, *Michigan* of 62 and *Indiana* a loss of 3, while the total increase in foreign students during the same period at the nine universities included in the above table amounts to 460.

Examining the foreign delegations of the different American institutions by continents, we observe that the order in North America is *Columbia, Pennsylvania, Harvard, Cornell;* in South America: *Pennsylvania, Cornell, Massachusetts Institute of Technology, Michigan;* in Europe: *Pennsylvania, Columbia* and *Harvard, Illinois;* in Asia: *California, Columbia, Illinois, Cornell;* in Africa: *Cornell, Northwestern* and *Pennsylvania;* and in Australasia: *Pennsylvania, Northwestern.* In the countries that send at least ten students to any one institution, the order is as follows: Canada: *Columbia, Harvard, Northwestern;* Central America: *Pennsylvania, Cornell, Massachusetts Institute of Technology;* Cuba: *Cornell, Pennsylvania, Syracuse;* Mexico: *Illinois, Pennsylvania, Massachusetts Institute of Technology;* Germany: *Columbia, Harvard* and *Pennsylvania;* Great Britain and Ireland: *Pennsylvania, Columbia* and *Illinois* and *Bryn Mawr;* Russia: *Illinois, Northwestern, California* and *Harvard;* China: *Cornell, Columbia* and *Illinois, Wisconsin;* India: *California, Harvard, Northwestern;* Japan: *California, Columbia, Illinois;* Turkey: *Yale, Illinois, Columbia;* and Australia: *Pennsylvania, Northwestern.*

Rudolf Tombo, Jr.
Columbia University

THE SMITHSONIAN EXPEDITION TO STUDY THE HEAT OF THE SUN

Director Abbot, of the Smithsonian Astrophysical Observatory, has just returned from a five months' astronomical expedition to Bassour, Algeria. The object of the expedition was to confirm or disprove the supposed variability of the sun. The Astrophysical Observatory has been for seven years making observations on Mt. Wilson, in California, on the daily quantity of heat received from the sun. The observations are arranged in such a manner as to indicate not only the quantity of solar heat reaching the earth, but also the quantity of heat which would reach a body like the moon, which has no atmosphere.

The observations have indicated that the sun is probably a variable star having a range of variation amounting to from five to ten per cent. within an irregular interval of from five to ten days. Last year Mr. Abbot observed in Algeria, while his colleague, Mr. Aldrich, observed on Mt. Wilson, in California. The object of thus duplicating the measurements was to avoid being misled by any local atmospheric conditions which might have affected Mt. Wilson observations. As nearly one third of the circumference of the earth lies between Mt. Wilson and Algeria, it could not be expected that a similar local disturbance could affect both stations at the same day in the same manner. The observations of 1911 strongly supported the belief that the sun is variable, but owing to cloudiness their number was not sufficient to fully establish this point. Hence, it was thought best to return to Algeria this year.

Mr. Abbot was assisted in Algeria by Mr. Anders Knutson Angström, of Upsala, Sweden. Mr. Angström comes from a distinguished family of scientists. His grandfather, Anders Angström, is the one of whom Kayser says in his great work on spectroscopy, "Now arose a man so great that his name will be forever associated with the history of spectroscopy." Mr. Angström's father, Knut Angström, was scarcely less distinguished than the grandfather, and invented many valuable instruments for measuring the radiation of the sun and earth. The present Mr. Angström is much interested in the same problems that occupied his father, and is now pursuing advanced work at Cornell University.

The observations made by the Smithsonian party in Algeria this year were apparently very satisfactory. They occupied sixty-four days, and on more than fifty of these days Mr. Fowle made similar observations on Mt. Wilson, in California. It can hardly be doubted that the results of the work of 1911 and 1912 will thoroughly establish the supposed variability of the sun, or will show conclusively that this hypothesis can no longer be held.

PROFESSOR MORRIS LOEB

At a special meeting of the board of trustees of the Chemists' Club of New York City, held October 8, the following resolutions offered by committee consisting of Mr. Ellwood Hendrick, Mr. Clifford Richardson and Mr. Walter E. Rowley, were adopted:

Whereas Morris Loeb, the president of the club, has been taken from us by death, and

Whereas he was the leading spirit in bringing to fulfillment ambitions and plans that had long been ours, and

Whereas he was always ready to shoulder burdens and to give help, and

Whereas he was a man of order, and of integrity in mind and in heart, sincere in scholarship, living without malice or scorn, speaking no evil, and generous in judgment, and

Whereas we were drawn to him by ties of deep and abiding affection, now, therefore, be it

Resolved, that we make this minute of our poignant grief at his passing, and that we cherish his memory as another of his great gifts to science and to humanity.

SCIENTIFIC NOTES AND NEWS

The autumn meeting of the National Academy of Sciences will be held in New Haven, beginning Tuesday, November 12, 1912, at 10 A.M. By invitation the sessions will be held in Sloane Physics Laboratory of Yale University.

Sir William Ramsay lectured at the Johns Hopkins University on October 18, when the degree of doctor of laws was conferred on him.

Nature states that Sir George Darwin, Plumian professor of astronomy at Cambridge University, has undergone a severe operation after which he is making good progress toward recovery.

The Fritz Schaudinn medal for work in microbiology has been awarded by the international committee to Dr. Carlos Chagas, of the Institute Oswaldo Cruz Manguinhos, Rio de Janeiro.

Dr. Carl Runge, professor of mathematics at Göttingen, recently Kaiser-Wilhelm professor at Columbia University, has been appointed "Geheimsregierungsrat."

Dr. Benjamin Boss, son of the late Dr. Lewis Boss, has been appointed acting director of the Dudley Observatory, Albany.

Colonel Martin V. Calvin, for the past six years director of the Georgia Agricultural Experiment Station, has announced his retirement from the station.

Mr. E. Grant Hooper, superintending chemist of the government laboratory, London, has been appointed deputy-government chemist, in succession to Mr. H. W. Davis, who has retired.

Dr. F. Bidling Meyer has been appointed director of the Observatory for Terrestrial Magnetism at the University of Munich.

Dr. A. B. Hamilton, who is now abroad, has been appointed a delegate from the University of Minnesota to the first International Congress of Comparative Pathology, which meets in Paris, October 17–23.

Professor Josiah Royce, of Harvard University, will give a course of eight Lowell lectures on Monday and Thursday afternoons beginning November 18, on "The Problem of Christianity."

A course of lectures at Union College on the Ichabod Spencer Foundation will be delivered by Dr. Rudolf Eucken, professor of philosophy at the University of Jena and visiting professor at Harvard University. The subjects of his lectures will be, "Goethe as a Philosopher," "Idealism and Realism in the Nineteenth Century," "Defence of Morality," and "Philosophy and Religion."

The sixth of the Weir Mitchell lectures of the College of Physicians was given on October 21 in Mitchell Hall by Dr. G. H. F. Nuttall, of Cambridge, England, on "Some Recent Advances in Our Knowledge of the Mode of the Spread of Protozoan Diseases."

Professor Borel, the French mathematician, is the guest of the University of Illinois this week. Professor Borel comes directly from Houston, Texas, where he has been attending the Rice Institute's inaugural exercises.

Among the recent lectures delivered by Dean Eugene Davenport, of the College of Agriculture, was one on "The Church and Country Life" delivered at Rantoul on October 11 and another on "Agriculture as a Career for Boys," delivered October 8 at the Illinois State Fair at Springfield. Some twenty men from the faculty of the College of Agriculture gave lectures and instruction at the State Fair Boys School of Agriculture.

At McGill University the annual university lecture for the current year was given on October 8 by Professor Francis E. Lloyd. He took for his subject "The Artificial Ripening of Bitter Fruits."

The first meeting of the Royal Geographical Society, London, will be held in the evening of November 4, when Miss Ellen Churchill Semple, of the University of Chicago, will give an amply illustrated lecture on "The Geography of Japan and its Economic Development."

Professor W. M. Flinders Petrie, F.R.S., will deliver the address on the occasion of the opening of the extension to the Manchester Museum on the afternoon of October 30.

The Henry Sidgwick memorial lecture at Newnham College will be given by Professor James Ward in the College Hall on November 9. The subject will be "Heredity and Memory."

Dr. William Willard Daniells, emeritus professor of chemistry of the University of Wisconsin, has died at the age of seventy-two years.

Dr. Frank S. Billings, formerly director of the Nebraska State Veterinary Hospital and a leading authority on veterinary surgery, has died at the age of sixty-seven years.

Professor Herm. F. Wiebe, a member of the Physical Reichsanstalt, has died at the age of sixty years.

The U. S. Civil Service Commission announces an open competitive examination for men only, for a specialist in agronomy in the Office of Experiment Stations, Department of Agriculture, at a salary of $1,800 per annum, and for associate physicist in the Bureau of Standards, Washington, D. C., at a salary ranging from $1,800 to $2,000.

Members of the American Association for the Advancement of Science expecting to contribute to the program of Section D are requested to so inform G. W. Bissell, secretary, East Lansing, Mich., as soon as possible. This section receives no support from affiliated societies, but the programs in the past few years have been good and the sessions well attended. The Cleveland meeting should be no exception.

The geographers who took part in the transcontinental excursion returned to New York last week and held scientific sessions in the hall of the American Geographical Society. On Friday evening there was a banquet at the Waldorf-Astoria. Most of the foreign geographers sailed for their homes on the nineteenth instant.

The 220 German physicians who have been visiting places of scientific interest in this country after the International Congress on Hygiene and Demography sailed on the morning of October 9 on the liner *Victoria Louise.*

The next International Physiological Congress will be held at Groningen from September 2 to 6, 1913.

A second exposition of inventions will be held at the coliseum, St. Louis, from November 11 to 17.

Mrs. Russell Sage has bought Marsh Island, Louisiana, at a cost of $150,000, for a bird refuge. The island is on the gulf coast, southwest of New Orleans, and is about eighteen miles long and nine miles wide, and contains about 75,000 acres. It has long been a famous winter feeding ground for ducks and geese and various other migratory birds, and has been for many years one of the most popular resorts in the south for market hunters. Mrs. Sage will place control of the island in whatever hands will best accomplish her purpose, either the federal government, the state of Louisiana or some association organized for bird protection. The matter was brought to Mrs. Sage's attention by Edward A. McIlhenny, of Avery Island, La., who, in conjunction with Charles Willis Ward, of Michigan, recently gave a 13,000-acre bird refuge on Vermilion Bay to the state of Louisiana.

The Somerset County Council has set aside Brean Down, a little promontory stretching into the British Channel as a sanctuary for birds, and the Society for the Protection of Wild Birds has provided a guardian.

A cable message has been received at the Harvard College Observatory from Professor Perrine, director of the Cordoba Observatory, from Christiana, Minas Geraes. Brazil, "Rain." This appears to indicate that observations of the eclipse of the sun on October 9–10 were prevented by bad weather.

The return of marriages, births and deaths registered in England and Wales, states that the number of persons married during the first quarter of the present year corresponds to an annual rate of 9.8 per 1,000 of the population; this is 1.5 per 1,000 below the mean marriage rate in the ten preceding first quarters and is the lowest marriage-rate recorded in any quarter since the establishment of civil registration. The births in the second quarter of the present year correspond to a rate of 23.9 annually per 1,000 of the population; this is 3.7 per 1,000 below the mean birth-rate in the ten preceding second quarters, and is the lowest birth-rate recorded in any second quarter since the establishment of civil registration. The deaths last quarter correspond to an annual rate of 12.7 per 1,000 persons living; this rate is 1.7 per 1,000 below the mean rate in the ten preceding second quarters, and is the lowest death-rate recorded in any second quarter since the establishment of civil registration.

On August 30 last, the Philosophical Institute of Canterbury, New Zealand, celebrated its jubilee by holding a conversazione in Christchurch, the capital of the province. There was a large gathering, local bodies, educational institutions and the parliament of New Zealand being represented. Among the guests were the Mayor of Christchurch and also Mr. G. M. Thomson, M.P., who has done much scientific work in the dominion. The president of the institute, Dr. L. Cockayne, F.R.S., presided. He delivered an interesting address, in which he showed what science has done for civilization, and what it is doing in New Zealand and in other parts of the world. He also briefly sketched the history of the institute, and referred to the work done in the past by Sir Julius von Haast (the first president), Captain F. W. Hutton and other members. He pointed out that in recent years the institute has taken important enterprises in hand, notably the publication of the "Index Faunæ Novæ Zealandiæ" and "The Subantarctic Islands of New Zealand," the latter a large two-volume publication, the result of a scientific expedition the institute was the means of sending to the Auckland and Campbell Islands, south of New Zealand, in 1907. During the evening, Mr. Thomson, on behalf of the board of governors of the New Zealand Institute, presented to Dr. Cockayne a sum of money, which accompanies the Hector medal, awarded for the first time some months ago. The medal was struck by the New Zealand Institute in memory of the late Sir James Hector, and has been awarded to Dr. Cockayne for his researches in ecological botany. At the gathering, a large number of messages were received congratulating the Canterbury Institute on attaining its jubilee, and Dr. Cockayne on having been elected a Fellow of the Royal Society. Amongst those who sent congratulatory messages were the Prime Minister of the Dominion (the Hon. W. F. Massey) and other members of the government. In a speech, Mr. Thomson announced that the government intended to help the scientific workers of the dominion, especially by offering them facilities in regard to the publication of scientific papers and reports.

The annual meeting of the Swedish Museums Association was held in Wisby, in conjunction with that of the Swedish Archeologists, on August 9–12, under the presidency of State Antiquary Dr. Oscar Montelius, who was reelected to the same office for the ensuing year, together with the secretary, Dr. R. Uppmark, and the treasurer, Dr. Otto Janse. The question of state contribution to provincial museums, which was discussed at last year's meeting and has since then been under the consideration of the Academy of Antiquities, was again discussed, and it was decided to approach the government with a request for the sum of, at most, 30,000 kronor ($7,700), to be distributed among provincial museums according to their respective means. The question of payment for treasure trove has also been under the consideration of the Academy of Antiquities. It was proposed that the term should include all objects of metal, both bronze and copper, as well as those silver; but it was decided that the final proposals of the Academy should be referred to all the provincial museums for their opinion, which should then be acted upon by the Museums Association. Among the papers read at the meeting were the following: "Sarcophagi and Reliquaries," and "Relics of Heathen Times in Gotland," both by Professor Montelius; "An Ancient Shrove-tide Custom," by Miss Louise Hagberg; "The So-called Battle Graves of Gotland," by Mr. Hans Hansson, in whose opinion these remains are not graves but ancient foundations; "The Country Churches of Gotland," by Dr. Sune Ambrosiani; "The Dwelling-houses of Gotland," by Lektor Karl A. Berlin; "The City Walls of Wisby," by Dr. Emil Ekhoff; "The Church Organs of Gotland," by Mr. C. F. Hennerberg; "The Church Furniture of Gotland," by Dr. Otto Janse; "Museum Technique," by Dr. Bernard Salin, director of Nordiska Museet, who dealt chiefly with registration and cataloguing. The concluding lecture by Lektor N. Klintberg, entitled "Sketches from the Peasant Life of Gotland" showed a selection from the large series of photographs which Dr. Klintberg has been taking for so many years in order to preserve for future generations a complete representation of every operation in the life of his fellow-countrymen—a life that retains so many characteristics of the middle ages but is now rapidly passing away. Excursions were made to the numerous ruins of Wisby, and to several of the churches and archeological remains on the island.

It is stated in *Nature* that the geological department of the British Museum (Natural History) has recently received a valuable gift of Wealden fossils from the Reverends P. Teilhard and F. Pelletier, S.J., who made the collection during a four years' residence near Hastings. A large proportion of the specimens are small teeth from bone-beds which had previously been very little examined, and among them is the unique mammalian tooth described under the name of *Dipriodon valdensis* by Dr. Smith Woodward in 1911. There are numerous teeth of the dwarf crocodile *Theriosuchus,* which has hitherto been known only from the Purbeck Beds. The series of plant-remains is also important and will shortly be described by Professor A. C. Seward in a communication to the Geological Society.

The experiments on orchard fertilization and cultural methods, started six years ago by Dr. J. P. Stewart, experimental pomologist of the Pennsylvania State College, are attracting attention from both official and practising horticulturists. Parties from foreign countries as well as from our own and neighboring states have recently visited a number of these experiments in company with Dr. Stewart. These parties have included Dr. Girolamo Molon, the leading horticulturist of Italy; Professor Niels Esbjerg, director of the Pomological Experiment Station at Esbjerg, Denmark; Professor J. W. Crow, head of the department of pomology at the Ontario Agricultural College at Guelph, Canada; Professors Price and Drinkard from the Virginia Experiment Station; and Mr. W. T. Creasy, president of the State Horticultural Association of Pennsylvania. This association held its summer meeting in one of the experimental orchards at which Mr. H. W. Collingwood, editor of *The Rural New-Yorker,* was present, besides representatives of other agricultural journals and several hundred practical fruit-growers and farmers.

UNIVERSITY AND EDUCATIONAL NEWS

Mr. George R. Agassiz has given Harvard University $25,000 for the general use of the Museum of Comparative Zoology; it is not to be used for anything connected with undergraduate instruction. An anonymous friend has given $10,000 to be used to rebuild the front portion of the central section of the Gray herbarium.

On October 6, Augustana College and the theological seminary, Rock Island, Ill., came into the possession of endowment funds amounting to $117,000. Of this amount $46,000 was given by the will of the late Senator C. J. A. Ericson, of Boone, Iowa, on condition that an equal sum in cash be raised. Mr. C. A. Smith, of Minneapolis, Minn., gave $25,000 to be used as a fund for purchasing books for the Senkman Memorial Library.

The arrangements for the administration of the Graham Bequest have been completed by the University of London. Dr. Charles Bolton has been elected director of research and Mr. H. G. Butterfield, Graham scholar. By means of the bequest 15 workers in the research laboratories of the school are in receipt of grants; a quantity of valuable apparatus has also been purchased and a special library furnished for the use of research workers.

At the last meeting of the board of trustees of the University of Illinois it was definitely decided that the College of Literature and Arts, and the College of Science should be consolidated into one college to be known as the College of Arts and Sciences. Although the board of trustees acted favorably upon the question nothing definite in regard to the details of the consolidation has been done.

Mrs. Huntington Wilson, of Washington, D. C., has established a lectureship on eugenics at the University of Virginia. Professor H. E. Jordan, of the university, has been selected as the lecturer.

Professor John M. Coulter, of the University of Chicago, gave the students of the Western College and their guests an address at the annual College Day festivities. Professor Coulter told of the power of social service in the individual life and how the individual ideal was changing, including in its conception the welfare of others in ways little known a decade ago. The laying of the corner stone of the new gymnasium was part of the ceremonies. Honorable Robert S. Fulton, of Cincinnati, made the principal address. He was followed by members of the alumnæ, by Honorable J. S. Crowell, president of the board of trustees, and by Mary A. Sawyer, acting president of the college.

The seventy-fifth anniversary of the founding of Mount Holyoke College was celebrated on October 8 and 9. The program on Tuesday consisted of alumnæ commemoration exercises in Mary Lyon chapel, with a pageant on the green in the afternoon. On Wednesday occurred the intercollegiate exercises in the outdoor auditorium including the dedication of the new memorial gateway. Of the fourteen honorary degrees conferred on this occasion the following names are noted. Dr. Mary Almira Smith, of Boston, D.Sc. The degree of LL.D. was conferred on President Alexander Meiklejohn, of Amherst College, Katharine Bement Davis, superintendent of Bedford Reformatory, Bedford, N. Y., Julia Clifford Lathrop, head of the Children's Bureau, Washington, D. C., and Lillian N. Wald, head of the Henry-Street Settlement in New York.

The following new buildings have just been occupied or are in course of construction at the University of Minnesota: the Institute of Anatomy, housing the departments of comparative anatomy and human anatomy; the new Millard Hall, providing quarters for the department of physiology and the department of medicine; the Main Engineering Building for mechanical and civil engineering, a mechanical laboratory for the same departments; a new laboratory for the school of chemistry; a Mechanic Arts Building with shops for the department of architecture; a new dairy barn for the division of animal husbandry.

Cornell University Medical College opened on Wednesday, October 2, 1912, with an enrollment as follows: for the degree of M.D., first year, 39; second year, 24; third year, 20; fourth year, 19; special students (work not leading to the degree of M.D.), 5; doctors in medicine engaged in research, 7; for the degree of Ph.D., 2; making a total of 116 students. There is an increase over last year of 15 students in the enrollment for the course leading to the degree of M.D. All students now registered, with the exception of those who are pursuing the combined seven-year courses leading to the degrees of A.B. and M.D. are graduates in arts or sciences, or doctors of medicine doing advanced work.

Dr. Edward Bradford Titchener, who has been Sage professor of psychology in the graduate school of Cornell University, has now been appointed head of the department of psychology and lecturer in the College of Arts and Sciences. He will give this year a course of lectures in elementary psychology.

Samuel Weiller Fernberger, Ph.D., instructor in psychology in the University of Pennsylvania, has accepted a similar position at Clark University.

Mr. F. C. Ayers, a graduate fellow last year of the University of Chicago, has gone to the University of Oregon as the head of the department of education.

Dr. L. R. Littleton, A.B. (Southern University, '07), M.A. (Tulane, '10), Ph.D. (Illinois, '12), has been appointed instructor in chemistry at Grinnell College to succeed Leonard M. Liddle, Ph.D. (Yale, '09), who has accepted a fellowship in industrial chemistry at the University of Pittsburgh. Mr. J. F. Mangold, B.S. (Cornell College, '07, CE., '10), has resigned the position of instructor in mechanical engineering at the Mississippi Agricultural and Mechanical College, to accept an assistant professorship in engineering at Grinnell College. He succeeds Mr. L. D. Norsworthy, who has been elected to an instructorship at Columbia University.

Dr. F. R. Miller has been appointed lecturer in physiology in McGill University.

Mr. R. E. Stone has been appointed lecturer in the botanical department of the Ontario Agricultural College.

Mr. W. H. Mills, M.A., of Jesus College, has been appointed demonstrator to the Jacksonian professor of natural experimental philosophy at Cambridge University in place of the late Mr. H. O. Jones.

DISCUSSION AND CORRESPONDENCE

"THEORETICAL ASTRONOMY"

To the Editor of Science: Referring to Professor MacMillan's review of Buchholz's Klinkerfues's "Theoretische Astronomie," in Science for September 6:

Professor MacMillan objects to Klinkerfues's limitation of the title "Theoretical Astronomy" to the theory and practise of orbit determinations, and the great majority of astronomers will certainly agree that this is illogical and unfortunate; but is not Professor MacMillan's application of the term "Computational Astronomy" to the same field even more illogical and unfortunate? The computational side in many other branches of astronomical endeavor is as extensive, both relatively and absolutely, as in that of orbit determinations. To illustrate: Studies of the solar corona, of atmospheric refraction, of the motion of the solar system, of Algol variable stars, of the evolution of double stars, of cosmogony in general, and so on almost indefinitely, have both theoretical and computational sides; and who is wise enough to say which side in any of the subjects mentioned will be the predominant one in the future?

Can we do better at present than to continue the already extensive use of Gauss's title, "Theorie der Bewegung der Himmelskörper," and of Oppolzer's title, "Lehrbuch zur Bahnbestimmung"?

Again, does not Professor MacMillan's characterization of this subject as the "bookkeeping" of astronomical science convey an unfortunate impression? The subject received the best efforts of Kepler, Gauss, Olbers, Oppolzer, and many others; and advances made during the present generation give promise that this field is worthy of the highest abilities of astronomers to come. Could we not, with equal justification, include in the "bookkeeping" of astronomy essentially all studies of double stars, of variable stars, of spectroscopic binary stars, of stellar positions and proper motions, of stellar radial velocities, of sunspot spectra, and so on through a long list?

W. W. Campbell

Mt. Hamilton,
September 18, 1912

THE UNANIMOUS VOTE RULE IN THE INTERNATIONAL COMMISSION ON ZOOLOGICAL NOMENCLATURE

The central branch of the American Society of Zoologists unanimously adopted the report of its committee on nomenclature[1] containing the following:

> All propositions for amendments to rules on nomenclature which are approved by a majority of the International Commission on Nomenclature shall be submitted to the International Congress for decision by vote in open meeting.

It is not the purpose of the present communication to influence any person's mind for or against the foregoing resolution, which is practically identical with a proposition that has recently arisen in Austria. A brief statement of the origin of the present method of procedure may, however, be interesting to some zoologists who desire a change in the methods.

The International Commission on Zoological Nomenclature was appointed in 1895. For three years it studied the subjects submitted to it, its members coming together at their own expense from five different countries in a meeting of nearly a week's duration some months prior to the meeting of the Congress. The Commission was unanimous upon a number of propositions, but was divided upon several others. Upon the latter propositions majority and minority reports were submitted.

At the next meeting of the Zoological Congress the Commission was prepared to submit its formal report, but learned that no place on

[1] See Science, 1912, June 14, pp. 933–934.

the program had been reserved for this purpose. As secretary of the commission I inquired into the reason, and was informed that the committee of the congress had decided that unless the report of the commission were unanimous, its submission to the general meeting would jeopardize the success of the congress, and would turn the general meeting into long-drawn-out discussions on very dry and technical points in nomenclature upon which very few of the members were well informed.

Accordingly, the first three years' work of the commission was not acted upon.

The commission was, however, granted a few minutes at one of the meetings to make a general report of progress and to request that the size of the commission be increased.

Three years later the commission had by mutual concessions obtained unanimous vote on most of its propositions, but there still remained several with divided vote. Repeated conferences were held with many different prominent zoologists, and the consensus of opinion was that the congress would not listen to any report that was not unanimous.

In order not to take up the time of the general meeting with technical discussions on nomenclature, the plan was instituted of having an open session when any person interested in nomenclature could present any point to the commission, and could discuss the commission's report. This open meeting is held prior to the date when the commission reads its report to the congress. The report is read, however, at this open meeting, and if any one present objects to any portion of it, he has to convince only one member of the commission that the portion in question should be stricken out. That one commissioner has the power to prevent the portion in question from going before the congress.

By this method of procedure the general meetings are safeguarded from being turned into discussions on nomenclature. Further, sudden and unwise changes in the rules are avoided. The theory is that if fifteen specialists on nomenclature can agree upon any one point, the mathematical probabilities are that that point is correct. Obtaining a unanimous vote thus assures the presentation of an amendment to the congress, and a failure to obtain a unanimous vote protects the rules from any sudden innovation and from vacillating changes that might be carried through with a vote of eight to seven, this vote changing from one side to another in successive congresses. At the Berlin Congress the motion was carried that the congress adopt and approve all of the propositions in the report that had been accepted unanimously by the commission, and that all propositions upon which there was a divided vote be referred back to the commission. The commission was also given thoroughly to understand that the congress did not care for any but unanimous reports in the future.

From the foregoing it will be seen that the present mode of procedure developed not upon the initiative of the commission, but of the congress itself, and in view of the experience the commission has had before two congresses, it seems that the commission can not be expected to report divided votes unless specifically instructed to do so by the congress.

An interesting point arises. A great many questions in nomenclature have been settled, and in not a few instances reports have been obtained only by mutual concessions after long conferences. When a commissioner has been outvoted in any given proposition, namely, when he has failed to obtain a unanimous vote for his proposition, it has been customary for him not to bring the matter forward a second time.

Assuming now that the recommendation of the central branch of the American Society of Zoologists is adopted by the congress, and that the commission is instructed to report divided votes in the future, the interesting point arises as to whether the large number of questions that have been definitely disposed of since 1896 under the present method of procedure will be reopened, and will be allowed before the general session of the congress.

C. W. Stiles,
Secretary, International Commission on Zoological Nomenclature

THE SYMBOLIC STATEMENT OF RELATIONSHIPS

The simplest way in which to state the relationship of two persons symbolically is to denote each by a number indicating the number of generations since the nearest common ancestor (counting that ancestor as one) and to write the numbers with a sign of relationship between them, that one being placed first whose relationship is to be expressed. A convenient and appropriate symbol of relationship is the ratio sign [:]. Thus the relationship of parent would be 1:2, of child 2:1. Here and elsewhere in this paper a person is regarded as his own ancestor, bearing to himself a relationship of identity [1:1]. The relationship of grandparent would be 1:3, of grandchild, 3:1, of great-grandparent, 1:4, and so on. That of brother or sister would be 2:2, of own-cousin 3:3, of second cousin 4:4, etc., the degree of cousinship being found by subtracting two from the symbol. The relationship of uncle or aunt would be 2:3, of niece or nephew 3:2, of great-uncle or aunt 2:4, and so on. This method also discriminates between relationships for which we have no separate names; thus we speak of a "first cousin once removed," whether we mean the older or younger of the two. The former would be symbolically, 3:4 and the latter 4:3. Likewise a third cousin four times removed would be 5:9 or 9:5. These are evidently as different relationships as parent and child or uncle and niece.

Suppose now we desire to take sex into account, as we do in our names when we distinguish between sister and brother or uncle and aunt. When we do thus distinguish we take account only of the sex of the person whose relationship is being stated. A male person is a brother alike to a male or female child of the same parents. A man is an uncle and a woman an aunt, no matter whether nephews or nieces are in question. In cousinships we do not consider sex at all in naming the relationships. We can do as much as this by attaching a sex initial (M for male and F for female) to the first number in the symbol, thus: 2(M):3 (uncle); 2(F):3 (aunt); 3(M):2 (nephew); 3(F):2 (niece).

But we may go further than our ordinary nomenclature and say 2(M):3(M) (the relation of uncle to nephew), 1(M):3(F) (relation of grandfather to granddaughter), etc.

Furthermore, we may, if desired, substitute for each number a series of sex-initials giving the line of descent in each case, and thus expressing facts that would require many sentences if we were to attempt to put them into words. Thus the following all express the relation of an elder to a younger second cousin once removed, the lines of descent by sex being different in the various cases

MMMM : MMMMM
MFMF : MMFFF
FFFM : FMMMF
etc. etc.

The first letters, since they denote the common ancestor, will in all cases be the same.

Hitherto no distinction has been made between relationship of the whole or of the half blood. Thus, in the first formula just above the common ancestor is a man, and there is no effort to tell whether or not the descent is through the same or different mothers. If it is desired to emphasize the fact that the relationship is of the whole blood the two letters (MF) may be used together when necessary. Thus, (MF)M:(MF)F is the relationship of own brother and sister, while FM:FF would be that of half brother and sister on the mother's side. Generally it will be necessary to make this distinction only in the case of the common ancestor. Intermarriages in the line, causing double relationships, introduce complexity. The only way to denote these is to make a symbol for each relationship separately and join them by a plus sign. In very complicated cases the symbol ceases to be an abbreviation and the diagram is clearer.

Suppose that a brother and sister marry a brother and sister, so that their children are double cousins. The relationship, if those children are boys, is:

[(MF)MM:(MF)FM] + [(MF)FM:(MF)MM].

Even here, the symbol becomes rather cumbersome, and this is the simplest case of a double relationship.

Arthur E. Bostwick

SCIENTIFIC BOOKS

Magnetism and Electricity. By Brooks and Poyser. Longmans, Green and Co. Pp. vii + 633; 413 illustrations.

This volume is intended by the authors to replace Poyser's "Advanced Magnetism and Electricity" as the latter book had become out of date owing to the enormous progress made in electrical theory during the last twenty years. The subject-matter is presented in experimental form; practically every point treated theoretically is illustrated by one or more experiments. The method is admirable, especially for a text in physics; as the authors state in the preface, it is important that a beginner should learn to recognize that all theory is based upon a groundwork of experimental fact. The book treats all of the subjects usually found in a text on electricity and magnetism and the treatment is very well done in most cases. The authors' emphasis upon the student's comprehension of the significance of the lines of force of the electric and magnetic field we think well worth while; the more the student is made to understand Faraday's ideas in regard to the electric and magnetic fields the better prepared he will be to understand the operation of instruments and machines.

The modern conception of the electric current as the flow of electrons is used in the book and its use is undoubtedly justified at this time, by the results obtained from the experiments of various researchers along this line. A chapter is devoted to the discharge of electricity through gases; in the discussion use is made of the latest theories in regard to this phenomenon. The chapters on Dynamos and Motors and on Alternating Currents are entirely inadequate to be of much service to the student. We think they should have either been omitted altogether or else treated more comprehensively. Any adequate treatment of dynamos and motors requires a deal of space and should not be attempted in such an elementary text.

A carefully selected list of problems is given at the end of each chapter and it adds much to the value of the book as a text. On the whole we think this text to be as well suited for teaching purposes as any that has recently come to our attention.

J. H. Morecroft

Columbia University

The Life of the Plant. By C. A. Timiriazeff. Translated from the revised and corrected seventh Russian edition by Anna Cheremeteff. New York, Longmans, Green, and Co. 1912. Pp. 355 with 80 text-figures. $2.50.

It is a great pity that this admirable popular presentation of the status of plant physiology might not have appeared in English some twenty-five years ago. Originally published in 1878 and passing through seven editions it can not but strike one familiar with the current literature as being distinctly behind the times, in spite of the evident effort to incorporate various modern investigations. For the specialist the translation has been too long delayed, and even for the general reader there are many views which should be modified in order to give as accurate as possible a notion of what the plant really does. On the other hand, it must be confessed that Professor Timiriazeff has presented the subject in such an attractive form that its very readableness is a strong point in favor of the book. Few of those who have any interest in botany whatever but that will enjoy reading "The Life of the Plant" and the great number of apt illustrations and demonstrations makes one wish that numerous American audiences might have had the opportunity of listening to such a course of lectures thirty-five years ago. The popular conception of a botanist would certainly be higher.

The book is neither a text-book nor a special treatise, but a simple account of the more fundamental life processes of the plant told in a way calculated to make them interesting if not "popular." For this reason it is hardly necessary to take it up page by page, as is so often done with volumes intended for students, and point out various slips, typographical and otherwise. The author disclaims any idea of expressing the whole truth, but feels the obligation of saying nothing but the truth. This limitation, not always felt by writers of popular works on botany, may be responsible for some of the omissions noted.

After a particularly good discussion of the relation of botanical science to society, one chapter each is devoted to the cell, the seed, the root, the leaf, the stem, growth, the flower, plants and animals and the origin of organic form. This latter chapter is distinctly pro-Darwin; in fact, there is little if any reference to the recent work along this line and the whole discussion smacks strongly of *Zweckmässigkeit.* The reason for adding as an appendix a lecture delivered in 1875 on the plant as a source of energy is not manifest. Unfortunately there is no index.

G. T. M.

The Toxicity of Caffein: an Experimental Study on Different Species of Animals. By William Salant and J. B. Rieger. Bureau of Chemistry Bulletin 148, pp. 98.
The Elimination of Caffein: an Experimental Study on Herbivora and Carnivora. By William Salant and J. B. Rieger. Bureau of Chemistry Bulletin 157, pp. 23.

One can not help feeling, on looking through these two bulletins filled with a wealth of detailed investigation on so important a drug as caffein, that the authors left no stone unturned in their quest for truth. So many experiments were made that their presentation in abstract form is extremely difficult. However, a few of the salient features can be briefly stated.

The principal object of the work describd in the first paper seems to be the determination of the toxic and of the fatal dose of caffein for the rabbit, guinea-pig, cat and dog. Theoretically this is simple. But as the authors have shown, the toxicity of caffein, like that of any other drug, depends upon such conditions as the age of the animal, its diet, the method of administering the drug, and still other factors which complicate the question of toxicity. Only after the most extensive investigation can all of the questions taken up in the bulletin be answered with any degree of certainty.

So strongly has the influence of diet, method of administration, etc., on the action of a drug been emphasized that one can not help wondering whether the toxic and fatal doses of caffein are really definite quantities for more than one set of experimental conditions. The conservatism of the authors, as exemplified in the following statement from page 91 of their bulletin, is certainly commendable: " . . . the most striking effect of caffein observed in the work herein reported was the comparatively wide range of variation in the resistance of individuals of the same species to this drug. This was found to be the case even when the conditions of experimentation were approximately uniform. . . ."

In their second bulletin the authors present their work on the elimination of caffein. They found that "Caffein administered subcutaneously, by mouth, or intravenously, is eliminated in part unchanged, in the urine, into the gastrointestinal canal, and into the bile. . . ."

Since the appearance of the above bulletins, at least two other pharmacological researches have been published which show how extremely careful the investigator must be before coming to final conclusions regarding the toxicity of a drug. In the *Proceedings of the Society for Experimental Biology and Medicine*[1] Kleiner and Meltzer describe some experiments on the reduction of the toxicity of strychnin by the simultaneous administration of large quantities of fluid. They state "that the toxicity of strychnin is definitely reduced not only when it is administered in great dilution, but also when saline or water is administered nearly simultaneously in other parts of the body, thus, perhaps, diluting the poison within the body. . . ."

Traube[2] states that the pharmacological ac-

[1] Vol. IX., p. 101, 1912.

[2] *Biochemische Ztschr.*, Bd. 42, p. 494, 1912.

tion of many alkaloids may be appreciably influenced by the presence of certain types of salts such as alkali carbonates.

Who knows but that the toxicity of caffein may be influenced by the mineral matter of the diet and by the quantity of water the animal drinks?

William N. Berg

Washington, D. C.

Catalogue of the Lepidoptera Phalænæ in the British Museum; Catalogue of the Noctuidæ in the Collection of the British Museum. By Sir George F. Hampson, Bart. Volume X., 1910, Volume XI., 1912. London (England).

The two volumes comprise 2,140 species, in the subfamilies Erastriinæ, Euteliinæ, Stictopterinæ, Sarrothripinæ and Acontiinæ. They are illustrated by two volumes of colored plates, Nos. CXLVIII. to CXIX., inclusive. There are also many cuts in the text illustrating typical species in each genus, giving both the general appearance and structural characters. Keys to the genera in each subfamily and to the species in each genus are given. There are also genealogical trees for each subfamily, showing the author's ideas of the evolution of the genera. The treatment is the same as in previous volumes of this work, which we have had occasion to notice. The genera are arranged upon adult structural characters, selected by the author. Resort has been had to many minor characters, such as modifications of the tuftings of the vestiture, tubercles on the front of the head, spines on the legs, etc. These characters are in many cases of little phylogenetic importance, so that the classification is to a large degree arbitrary and artificial. This appears distinctly in the arrangement of species within the genus also, where primary groups are made on modifications of antennal structure in one sex and other secondary sexual characters, so that really closely allied species are often widely separated. It would be rather difficult, however, to have avoided this and still keep the keys in a workable condition, especially where the vast majority of the early stages and life histories are unknown, as is the case with these insects. The nomenclature of the North American species included in the book is greatly changed from that familiar to us. This appears to be unavoidable, as the classifications of different authors based on restricted faunal regions are here combined. The names here established will probably tend to be permanent. as it will be long before any one attempts to treat the Noctuidæ of the world on new lines with material equal to that afforded by the British Museum.

The British Museum collection, rich as it is, does not make a practise of retaining long series of specimens of common species. Consequently the author of these catalogues occasionally suffers from lack of sufficient material. We notice in the genus *Iscadia* (vol. XI., p. 362) some errors due to this cause. The subfamily Sarrothripinæ, to which *Iscadia* is assigned, is defined by the presence of a bar-shaped retinaculum on the fore wing of the male. In *Iscadia aperta* Walker and *I. duckinfieldia* Schaus this is absent. Sir George notes its absence in *I. aperta,* but having only one male he supposes it may have been broken off. Furthermore, *I. aperta* has simple flattened antennæ in the male, not bipectinate, as given in the table. *I. duckinfieldia* is abundantly distinct from *I. aperta,* not possibly an aberration, as suggested, for it has pectinated antennæ in the male and differs in markings, the double black line above the reniform-mark being absent. The separation of *I. duckinfieldia* on the brown costal shade is ineffective, as this shade is as often absent as present. These imperfections would have been obviated by larger series of specimens of these rather common species.

Harrison G. Dyar

SPECIAL ARTICLES

THE NATURE OF THE FERTILIZATION MEMBRANE OF THE EGG OF THE SEA URCHIN (ARBACIA PUNCTULATA)

Many widely held hypotheses, *e. g.,* on the dynamics of cell division, etc., are based on the nature of the fertilization membrane of the sea urchin egg. The methods which have been used heretofore in the study of this so-called membrane have been inadequate to determine its exact nature. The writer has made some observations, by the use of methods which are apparently new to this field, which seem to throw a new light on the structure of the various coatings on this egg. As is well known, there has been no agreement among cytologists concerning the number and nature of the coverings of this egg. A few investigators have recognized the presence of a thick jelly surrounding the egg, but have given us no methods of demonstrating its true extent or nature. Further, no one has used methods by which the physical characteristics of the vitelline membrane could be determined in the living egg, and the relation of this membrane to the cytoplasm on the one hand and to the egg-jelly on the other.

The normal unfertilized egg is covered by a soft invisible jelly about 23 microns in thickness. Beneath this and closely stuck to the surface of the cytoplasm is a tough somewhat elastic vitelline membrane. Morphologically, this latter is the only membrane on the egg of *Arbacia.* It is literally glued to the outer surface of the cytoplasm. The average of a number of measurements shows that the vitelline membrane is about 1.9 microns in thickness. In the living egg the inner part of this structure is seen as a light line on the outer surface of the cytoplasm when the light is sufficiently stopped down. The refractive index of the outer part is so nearly that of sea water that this portion is invisible.

In the reaction of the egg to the spermatozoon, striking morphological changes occur in the vitelline membrane and the surface of the cytoplasm. The change in form of the egg-jelly is slight. About one and one half minutes after active spermatozoa are mixed with the eggs, a definite swelling of the vitelline membrane occurs. The extent and location of the swelling varies greatly in different eggs. In some eggs the swelling is complete in one minute, but three to five minutes are usually required for the maximum swelling of this structure. During the swelling of the vitelline membrane its refractive index is so changed that it usually becomes distinctly visible by the usual microscopical examination. When swelling is complete the thickest portion of this structure frequently measures as much as nine microns. About six minutes after insemination of the eggs the surface of the cytoplasm swells and changes its refractive index. In one minute the swelling is complete and measures about one micron in thickness. This is the well-known hyaline plasma-layer. By the time the swelling of the vitelline membrane has become well advanced, a change occurs in the refractive index of the inner part of the egg-jelly and this becomes visible. As seen by the usual microscopical examination the so-called fertilization membrane of the egg of *Arbacia* consists of three parts, viz., the inner part of the egg-jelly which has undergone a change in its refractive index, the swollen vitelline membrane and the thin highly refractive surface layer of the cytoplasm. This hyaline layer is still very adherent to the vitelline membrane. The edematous vitelline membrane is softer and more elastic than it is in the unfertilized egg. If this structure is partially dissected from the fertilized egg it frequently contracts to a glutinous mass on one side of the cytoplasm. The relation of the hyaline plasma-layer to the vitelline membrane and the cytoplasm is brought out very clearly in fertilized eggs which have been plasmolyzed by adding cane sugar to sea water. The protoplasm shrinks and the hyaline layer frequently takes on the appearance of pseudopodial-like processes of the cytoplasm. When the vitelline membrane is dissected from the egg, the hyaline layer remains as an organic part of the cytoplasm. These methods leave no doubt as to the nature of this structure; it is the swollen surface of the cytoplasm and enters into the formation of the larval sea urchin. The water-holding power of the hyaline layer and of the edematous vitelline membrane is striking. These structures do not show an appreciable shrinkage in quite concentrated solutions of cane sugar in sea water.

Three methods have been used singly and in various combinations in this study. By the plasmolytic method a separation of the hyaline plasma-layer from the vitelline membrane is easily affected. Vital staining differentiates clearly the various structures on the surface of the egg. Janus Green (dimethylsafraninazodimethylanalin) in dilute solutions stains the egg-jelly light blue. It is also beautifully demonstrated by a number of other vital stains. In concentrated solutions of janus green the jelly shrinks to a mere hull. Slightly concentrated solutions of isamin blue, dissolved in sea water by boiling, stain the swollen vitelline membrane a deep blue while the hyaline layer is much lighter in color. Toluidin blue stains the hyaline layer of the cytoplasm and the vitelline membrane, but as a differential stain it does not equal isamin blue.

The removal of the egg-jelly and vitelline membrane from the fertilized and unfertilized eggs was affected by dissection with glass needles made from very hard Jena glass tubing about 5 mm. in diameter. The points on many of these needles measured less than one half micron. The needles were held in a Barber pipette-holder and the dissections made under a magnification of five hundred and sixty-two diameters.

It seems that the type of reaction described for the egg of *Arbacia* is a somewhat common one, since essentially the same changes occur in the eggs of *Chætopterus* and the mollusk *Cumingia.* In these two forms the maximum swelling of the vitelline membrane does not occur until about twenty to thirty minutes after insemination of the eggs.

An analysis of the reaction of the egg of *Arbacia* to the spermatozoon has been attempted. Puncture of the vitelline membrane has failed to produce the reaction. Doses of from one to five spermatozoa have been injected into the egg-jelly and the relation between the time required for the penetration of the vitelline membrane by the spermatozoon and the extent and location of the swelling of this structure have been studied. By injecting spermatozoa into the egg-jelly, in a small percentage of cases a single spermatozoon becomes attached to the vitelline membrane and produces the reaction that has been described. The passage of the spermatozoon through the vitelline membrane has been observed in a number of eggs. It has been found possible to remove the spermatozoon from the vitelline membrane after it has caused the reaction. The real difficulty in this type of experiment is not the size of the spermatozoon, but the fact that when even four or five spermatozoa are injected into the egg-jelly they usually swim out and away from the egg. This necessitates the making of many injections in order to get a single spermatozoon to attach itself to the vitelline membrane and start the reaction.

As far as my evidence goes at the present time it seems that the primary function of the much discussed reaction of the egg of *Arbacia* to the spermatozoon is the prevention of polyspermy.

The details of this study will appear later.

G. L. Kite
The Marine Biological Laboratory,
Woods Hole, Mass.,
September 7, 1912

A SIMPLE METHOD OF MAKING ARTIFICIAL CELLS RESEMBLING SEA URCHIN EGGS IN CERTAIN OF THEIR PHYSICAL PROPERTIES

Several years ago Robertson showed that if chloroform was shaken with egg-albumen solution, the droplets would not reunite even when washed in water, because of the formation of a proteid film on the chloroform surface. It can be readily observed that such droplets shrink in volume, owing to the passage of chloroform into the water outside.

While studying the penetration of alkalies into lecithin in various solvents, I noticed that if lecithin is dissolved in chloroform and the solution shaken with proteid solutions, the chloroform of the resultant globules is in time completely replaced by water. Eventually, then, instead of lecithin in chloroform, we may obtain small cells of lecithin in water surrounded by a fine proteid membrane. This membrane is impermeable to lecithin.

During the exchange of water for chloroform a characteristic structure appears in the droplet. It is at first clear but within 30 seconds becomes filled with a dense mass of granules (probably water) so that it looks white against a dark background. The droplet is still mostly chloroform, as may be determined by pricking it with a needle. The contents do not mix with the water.

In the course of an hour, the dense granular structure disappears and the drop clears. There remain only a few dense granules (probably some form of lecithin) mostly aggregated together to form an excentric knot like a karyosome. It is in this stage, which is stable and persists until destroyed by bacteria, that the resemblances to sea urchin eggs are most marked.

If pricked with a needle the contents flow slowly out as a viscid protoplasm-like mass and mix (except the granules) with the water. No chloroform is now present.

The cells are not rigidly spherical in shape, as oil globules suspended in water, but present exactly those slight irregularities which may be observed in freshly laid sea urchin eggs.

The surface film is similar to the surface membrane of a sea urchin egg in appearance and also in consistency, as indicated by its resistance to pricking and to pressure.

Neutral red is accumulated from dilute solution by the cell as a whole but in particular by the granules, which stain very deeply.

Such red stained cells are turned yellow at the same rate by $n/2,000$ NaOH and $n/2,000$ NH_4OH. In regard to their permeability relations they therefore differ markedly from marine eggs, which are entered much more rapidly by NH_4OH. They possess also no polarity except one attributable to gravity.

These artificial lecithin cells resemble egg cells in one more important and striking respect. If a trace of saponin is added to the sea water in which sea urchin eggs lie, the eggs almost instantly swell and the contents become more fluid and clear, *i. e.*, the eggs cytolyze. Exactly the same thing happens when a trace of saponin is added to water containing lecithin cells. They swell and become clear spheres with only a few granules in the interior. The similarity is indeed perfect.

Future work may indicate methods by which protein can be obtained within a lecithin membrane, the whole of a size comparable with cell size, or can be introduced into lecithin cells. Such cells promise to exhibit even more striking and interesting properties than those herein described.

E. Newton Harvey
Woods Hole, Mass.,
September 6, 1912

A METHOD OF DETERMINING THE AVERAGE LENGTH OF LIFE OF FARM EQUIPMENT

In determining the cost of farm operations one of the most difficult items to determine accurately is the rate of depreciation of farm equipment. Recently Mr. H. H. Mowry, of the Office of Farm Management, who has collected extensive data on the problem of depreciation of farm equipment, suggested to the writer the possibility of determining the average length of life of a farm implement from data relating to the number of years each implement has been used. Apparently a solution for this problem has been found. The solution applies to all objects, either animate or inanimate, lasting for varying lengths of time.

Two cases are to be considered, namely, (1) when the number of the objects under consideration is approximately constant from year to year, and (2) when their number is increasing or decreasing. The first case may be conveniently considered in its application to farm dwellings. Suppose that on a given group of farms there is a definite number of farm dwellings of various ages, and that as fast as old dwellings become unsuited to their purpose they are replaced by new ones. For convenience of reference let us reduce the numbers with which we have to deal to symbols. Let N_1 represent the number of dwellings in their first year of life, N_2 the number in their second year, N_3 the number in their third year, and so on, N_n representing the number of dwellings of the oldest age represented in the group.

In any group of objects which last for varying lengths of time but in which the number of objects is kept constant by replacing discarded ones by new ones the following principles apply:

1. The number of old objects discarded each year is, on the average, equal to the number of new ones introduced.

2. The average number of objects in the second year of their life at a given time is equal to the average number of those in their first year that will live to enter their second year. The average number in their third year is on the average equal to the number of those in their first year that will live to enter their third year, and so on. In general, the number of objects in their nth year is equal to the number of those in their first year that will live to enter their nth year.

3. Hence N_2, N_3, etc., which represent the number of objects now in their second, third, etc., years of life, may also be taken to represent the number of the objects now in their first year that will ultimately reach their second, third, etc., years of life.

4. If now we add together N_1, N_2, N_3, etc., this is equivalent to counting each object now in its first year as many times as it will live years. Hence the sum of N_1, N_2, N_3, etc., which represents the total number of objects of all ages, also represents the sum of the ages that will be attained by all the objects now in their first year.

5. Therefore, if we divide the total number of objects of all ages in the group by the average number in their first year the quotient will be the average length of life that those now in their first year will live. But since the average number of objects in their first year is the same from year to year, this average is a general one and applies to the whole population. We may thus express the average length of life of any constant population by means of the following formula:

$$L = \frac{N_1 + N_2 + N_3 + \cdots + N_n}{N_1}. \qquad (A)$$

This formula may be expressed more simply by writing for the numerator simply the total population instead of the sum of individuals of different ages. We thus have

$$L = \frac{P}{N_1}. \qquad (B)$$

In this formula L equals the average length of life, P the total population, and N_1 the average number in their first year of life at a given time.

In applying either of the above formulæ to cases like those of farm houses and most kinds of farm implements the fact that very few such objects are discarded until they are at least four or five years old makes N_1, N_2, N_3, N_4 and N_5 approximately equal. That is, the number of objects one year old is about the same as the number two years old, or three years, etc., up to about five years, and sometimes even longer. In making a study of such objects with a view to determining the average length of their life it is usually possible to get quite accurately the number of objects in the group in each year of life up to five or six years of age, and where these numbers are about the same for each year their averages will represent quite accurately the average number of new objects introduced in a year, which is the same as the average number of old ones discarded. Hence, in populations where the number of objects in each of the earlier years of life is approximately the same, the average length of life in the population may be obtained by dividing the total number of objects by the average number in each of the early years of life.

POPULATIONS THAT ARE DECREASING OR INCREASING

The principles stated above do not apply in a population that does not remain constant from year to year. It is not difficult, however, to work out a formula based on formula (A) above that does apply to such populations. This may be done as follows:

Suppose the rate of increase in population is 1 per cent. a year. Then if P represents the population in any one year, $1.01P$ will represent the population the next year. Likewise, if B represents the number of births in any year, then $1.01B$ will represent the number the next year. In general, if B represents the number of births in any year and r the annual rate of increase in population, then $(1+r)B$ will represent the number of births the first year thereafter, $(1+r)^2B$ the number of births the second year thereafter, and $(1+r)^nB$ the number of births the nth year thereafter.

Returning now to formula (A), where N_1 represents the number of individuals in the first year of life, N_2 the number in their second year, and so on, we have already seen that in a constant population these numbers bear such relation to each other that N_2 represents the number of the present N_1's that will live to enter their second year. But in an increasing population this is not the case, for the number of individuals born in the year in which the present N_2's were born was smaller than the number born in the year in which the present N_1's were born—that is, the number born last year is smaller than the number born this year. Hence, in an increasing population N_2 is smaller than the number of N_1's that will live to enter their second year. But if we increase N_2 in proportion as the number born this year is greater than the number born last year, this increased value of N_2 will represent the number of the present N_1's that will live to enter their second year.

If we let B stand for the number born in the year in which the present N_2's were born, then $(1+r)B$ will represent the number born the year the present N_1's were born, which of course is just one year later. The increased value of N_2, for which we are seeking, may now be found from the proportion

$$B : (1+r)B :: N_2 : X,$$

from which

$$X = (1+r)N_2.$$

In similar manner it can be shown that if we substitute for N_3 the expression $(1+r)^2N_3$ this new value will represent the number of present N_1's that will live to enter their third year, and so on for all of the various N's in the numerator of formula (A). This gives us

$$L = \frac{N_1 + (1+r)N_2 + (1+r)^2N_3 + \cdots + (1+r)^{n-1}N_n}{N_1}. \quad (C)$$

In this new formula the terms of the numerator represent, respectively, the number of the present N_1's that will live to enter the various years of life indicated by the subscripts after the N's. Hence the sum of the terms of the numerator is equal to the sum of the ages the present N_1's will reach at death, and the value of the whole fraction becomes the average length of life of the population.

To use formula (C), which applies to populations that are increasing or decreasing at a constant rate, r, we must know the number of individuals in each of the various years of life at the present time and the annual rate of increase or decrease in population. Such data are usually not available except in the cases of human beings in restricted areas where births and deaths are accurately recorded. In some cases, however, it may be possible to obtain data of this kind concerning a class of articles of farm equipment. When this is possible, the average length of life may be calculated where the number of objects is increasing or decreasing at a constant rate per year.

It will be noticed that when r is equal to zero, which it is in a constant population, formula (C) becomes identical with formula (A).

Formula (C) applies only to populations in which the *rate* of increase or decrease is the same from year to year. It is possible to develop another formula for the average length of life which is independent of the rate of increase and which therefore applies to any kind of population, no matter what the rate of increase or decrease, and whether this rate is the same from year to year or not.

Let B_3 represent the number of individuals born the year the present N_3 individuals were born, and B_1 the number born the present year. Then the proportion $B_3 : B_1 :: N_3 : X$, in which X is equal to $(B_1/B_3)N_3$, gives a value which if used instead of N_3 makes the third term of the numerator of formula (A) represent the number of the present N_1's who will live to enter their third year. The other terms of the numerator of formula (A) may be modified in similar manner, giving the formula

$$L = \frac{N_1 + \frac{B_1}{B_2} N_2 + \frac{B_1}{B_2} + N_3 \cdots + \frac{B_1}{B_n} N_n}{N_1}, \quad (D)$$

which is applicable to all populations for which we have the following data: the number of individuals born each year since and including the year in which the oldest individuals now living were born, and the number of people of various ages now living.

While formula (D) has very wide applicability, its usefulness is greatly limited by the fact that it requires so large an amount of data which is usually difficult to obtain.

Before applying any of these formulæ it is necessary to eliminate the effect of immigration and emigration. This means that only those individuals should be considered whose whole life is to be spent as a part of the population under consideration. In using any of the methods here presented in determining the average rate of depreciation of, say, a farm implement of a given kind, only those implements are to be counted that were bought new (not second hand) and which will presumably be replaced when destroyed or worn out by new ones.

W. J. Spillman

Washington, D. C.

QUARTER CENTENNIAL OF THE IOWA ACADEMY OF SCIENCE

On Friday and Saturday, April 26–27, the Iowa Academy of Science celebrated the twenty-fifth anniversary of its organization. The sessions were held in the Art Gallery of the State Historical Building in Des Moines, beginning at 1:30 Friday afternoon. The president's address was given by Professor Louis Begeman, of the State Teachers College, on "The Mission and Spirit of the Pure Scientist." After the president's address the reading of the usual scientific papers as presented before the academy was the order of the afternoon. As forty-six titles were presented, it was necessary that the time allotted to each paper be very brief.

The anniversary banquet was held Friday evening at the Chamberlain Hotel, with an attendance of seventy. At the close of the banquet short addresses of congratulation were given by representatives of neighboring scientific societies. The Nebraska Academy of Science was represented by Professor Addison E. Sheldon, the Illinois Academy of Science by Professor Henry B. Ward, the Davenport Academy by Professor C. C. Nutting, the St. Louis Academy by Professor L. H. Pammel, the American Microscopical Society by Professors H. E. Summers and L. S. Ross and the Ohio Academy by Professor Herbert Osborn. An address on the "Charter Members" was given by Professor L. H. Pammel and the anniversary address by Professor Herbert Osborn, of the State University of Ohio, the first president of the Iowa Academy.

In accordance with the purpose of the anniversary meeting, the session Saturday forenoon was devoted to addresses on "The Development of the Sciences in Iowa during the Past Twenty-five Years":

- Botany—Professor Thomas H. Macbride.
- Chemistry—Professor W. S. Hendrixson.
- Geology—Professor M. F. Arey.
- Physics—Professor Frank F. Almy.
- Zoology—Professor C. C. Nutting.

These papers gave valuable reviews of the status of the sciences in the colleges at the time of the organization of the academy, and historical sketches indicating marked advance in all scientific lines during the quarter century.

At the business meeting, over eighty applications for membership were presented. The meeting was in every way fitting to celebrate the end of a quarter century of earnest and effective work done by the academy.

The 1913 meeting will be held at the Iowa State College, Ames.

TITLES OF PAPERS PRESENTED

(Abstracts furnished by authors)

Ferns and Liverworts of Grinnell and Vicinity: H. S. Conard.

Secotium warnei, a Stalked Puffball: H. S. Conard.

Simblum rubescens in Iowa: H. S. Conard.

Aroid Notes: James Ellis Gow.

In studying the morphology of some twenty species of Aroids, mostly tropical, the writer found that there is great confusion in the nomenclature of the species. A reference to the original sources has made it possible to give a correct account of the taxonomy of all but one species, and the results are here presented.

Behavior of Pollen Tubes in Richardia Africana: James Ellis Gow.

An Anomalous Ovary: James Ellis Gow.

The Late Blight of Barley—Helminthosporium teres Sacc.: A. L. Bakke.

Some Points on the Floral Development of Red Clover (Trifolium pratense): J. N. Martin. Introduced by L. H. Pammel.

Native Dye-plants and Tan-plants of Iowa with Notes on a Few Other Species: Harriette S. Kellogg.

The Genus Lycoperdon as Represented in the Herbarium of the State University of Iowa: N. D. Knupp.

Notes on Heteranthera dubia: R. B. Wylie.

Notes on Some Parasitic Fungi Chiefly from the Bitter Root Mountains: L. H. Pammel and Ella Grace Harvey.

The Effect of Continued Grinding on the Water of Crystallization (second paper): Nicholas Knight.

The Dynamics of the Reaction between Ethyl Iodide and Silver Nitrate in Ethyl and Methyl Alcohol and in Mixtures of these Solvents: O. M. Weigle and J. N. Pearce.

The Solubility of Lead Sulphate in Aqueous Solutions of Sulphuric Acid: P. A. Jans and J. N. Pearce.

The First Reported American Lepidostrobus is from Warren County, Iowa: John L. Tilton.

The paper records the discovery of the specimen, the conditions under which it had been preserved and evidences that in other places may lead to the discovery of specimens of equal interest. It was illustrated by the specimen itself and by lantern slides of prepared sections.

Nether Delimitation of our Carbonic Rocks: Charles R. Keyes.

Singularly enough the base of the Carbonic rocks in Iowa has never been definitely recognized; neither has the top of the Devonic sequence. The present paper records the facts recently discovered which go to show that there is a marked unconformity between the two great formations. This basal terrane of the Carbonic strata is the Grassy black shale of Missouri, which has always been regarded as of Devonic age. Its northern continuation proves to be the Sweetland shale of Muscatine County.

Arid Plateau Plains as Features of Eolic Erosion: Charles R. Keyes.

One of the great difficulties in the consideration of eolic erosion has been the securing of quantitative data, and direct proofs that supposable examples are not possibly the results of stream-corrasion. These proofs are believed to be found in the lava-capped mesas of excessively dry regions.

Sundry Provincial and Local Phases of the General Geologic Section of Iowa: Charles R. Keyes.

Certain features of the stratigraphy of the state are briefly discussed in the light of recent advances in geologic classification. The present need appears to be a careful revision of the nomenclature of the geologic formations now recognized and a detailed study of certain of the larger groups with a view to properly subdividing them.

The Salem Limestone and its Stratigraphic Relations in Southeastern Iowa: Francis M. Van Tuyl.

Recent stratigraphic studies have suggested that a limestone member formerly regarded as the basal portion of the St. Louis is distinctly formational in character and is of the horizon of the Salem limestone of Illinois and Indiana. Unconformities occur both at the base and at the top of the formation.

The Origin of the Geodes of the Keokuk Beds: Francis M. Van Tuyl.

Previous theories of the origin of the geodes are briefly discussed and evidence is presented to show that these theories are untenable. The presence in the beds at some localities of calcareous nodules grading into geodes suggests a method of geodization not previously recognized.

A Study in the Cherts of the Osage Series of the Mississippian System: Francis M. Van Tuyl.

Cherty nodules and bands are prominent features of the Burlington and Keokuk limestone members of this series. Excellent facilities for studying the chert were recently afforded in the power-plant excavation at Keokuk. In the discussion of the origin of the material it is concluded that it has resulted from the metasomatic replacement of the limestone.

A Method of Teaching Elementary Mineralogy: G. F. Kay.

A Survey of the Water-bearing Gravels at Estherville, Emmet County, Iowa: G. G. Wheat.

Additional Evidence of Unconformity between the Cedar Valley and Lime Creek Stages of the Devonian of Iowa: A. O. Thomas.

The type outcrop showing unconformity is described; several similar outcrops are noted. A new substage, tentatively called the Floyd limestone, is added at the base of the Lime Creek stage.

Some Notes on the Aftonian Mammals: A. O. Thomas.

A number of interesting mammalian bones and teeth have been added to the State University collection during the past year. They are chiefly remains of the elephant, horse and camel. The finding of the lower jaw of a beaver adds a new genus to this remarkable faunal assemblage.

Early Iowa Locality Records: B. Shimek.

A discussion of the early Iowa plant, mollusk and insect records in the earlier reports, such as those of the Lewis and Clark, Long, Nicollet and Owen expeditions. Also a discussion of the "Council Bluff," Nebraska, records which are sometimes thought to refer to Council Bluffs, Iowa.

The Phase Difference at the Ears Produced by a Simple Source of Sound: G. W. Stewart.

A New Laboratory Apparatus for Measuring Time, Independent of Clock or Chronograph: F. C. Brown.

Evidence Favoring the Chemical Disintegration of Sodium as an Element: F. C. Brown.

The Effect of Mechanical Rupture on the Electrical Conductivity of Selenium: F. C. Brown.

A Method of Determining Whether the Restoring Torque is Proportional to the Torsional Strain during the Vibration of a Torsional Pendulum: L. P. Sieg.

The Influence of an Electric Current upon the Elasticity of Wires: H. L. Dodge.

A Simple Laboratory Equipment for the Elementary Study of Alternating Currents: H. L. Dodge.

On the Dissimilarity of Light and Heat Action in a Certain Variety of Selenium: E. O. Dieterich.

Mollusca of Iowa: T. Van Hyning.

A Study in Insect Parasitism: R. L. Webster.

An account of certain insect parasites reared from the common tomato-worm, *Phlegethontias sexta* Johanssen, the relations of these parasites to the host and to each other, and their comparative abundance, etc.

A Systematic Study of the Reduviidæ of North America: S. B. Fracker.

Notes on a Collection of Mammals from Northwestern Iowa: Alexander G. Ruthven and Norman A. Wood.

Contributions to the Herpetology of Iowa—II.: Alexander G. Ruthven.

Food Habits of Red-tailed Hawk, Cooper's Hawk and Sparrow Hawk: F. C. Pellett.

The Interpretation of the Cardio-sphygmogram and the Electro-cardiogram, Normal and Pathological: W. E. Sanders.

The Source of the Chromaffine Cells in the Guinea-pig: Mildred R. Yule.

Notes on the Food of the Black-crowned Night Heron in Captivity: B. H. Bailey.

The Occurrence of Melanism in the Broad-winged Hawk: B. H. Bailey.

A Remarkable Flight of Broad-winged Hawks: B. H. Bailey.

L. S. Ross,
Secretary

SOCIETIES AND ACADEMIES

THE PHILOSOPHICAL SOCIETY, UNIVERSITY OF VIRGINIA. MATHEMATICAL AND SCIENTIFIC SECTION

The first meeting of the session 1912–13 of the Mathematical and Scientific Section was held September 23, 8:00 P.M. The following officers were elected:

Chairman—Professor Llewelyn G. Hoxton.

Secretary—Profesor Wm. A. Kepner.

Publication Committee—Professors W. H. Echols, J. L. Newcomb and Thomas L. Watson.

The retiring chairman, Professor Thomas L. Watson, read by title a paper on "Kragerite, a Rutile-bearing Rock from Krageros, Norway." Professor Watson read a second paper entitled "Vanadium and Chromium in Rutile and the Possible Effect of Vanadium on Color."

Professor R. M. Bird reported observations made along New River, Virginia to North Carolina.

Wm. A. Kepner,
Secretary

University of Virginia

THE ELISHA MITCHELL SCIENTIFIC SOCIETY

The 200th meeting of the society was held October 15 in Chemistry Hall, University of North Carolina, Professor E. V. Howell presiding. The following new members were elected: Professor H. W. Chase and Mr. J. S. Holmes. The following papers were read:

"Chemical Control of Industrial Plants," by Dr. C. H. Herty.

"The Water Molds of Chapel Hill," by Dr. W. C. Coker.

James M. Bell,
Recording Secretary

Chapel Hill, N. C.

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THE AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE

SOME CHEMICAL RELATIONS OF PLANT AND SOIL[1]

IN order to arrive at a satisfactory theory of living matter it is evidently necessary to know what substances are indispensable to metabolism and to ascertain the rôle of each of these substances.

Despite much study it is not yet clear what constituents of the soil are absolutely needful for plants. An excellent example is found in sodium chloride, which is indispensable for animals, but is generally thought to be unnecessary for plants. This difference between plants and animals would be of fundamental importance if true in all cases, but recent experiments have shown that sodium chloride is just as necessary for many marine plants as it is for animals. It would not be surprising to find cases where sodium or chlorine are likewise necessary for land plants.

The condition in which the necessary substances exist in the soil has both practical and theoretical importance. In certain forms they are said to be "available" to the plant, in others not. A convenient method of determining quantitatively the substances which are "available" in a soil is one of the prime needs of practical soil study. In view of the difficulties with existing methods it would seem worth while to try to separate the available salts from the soil by means of an electric current.

[1] An address delivered at the Symposium on the Soil before Section G, American Association for the Advancement of Science, at Washington, 1911, the scope being limited to a brief presentation of elementary principles.

The chief process by which plant food becomes "available" is weathering, in which water and carbon dioxide play the chief rôles. The plant's supply of mineral salts as well as of carbon thus depends on the supply of carbon dioxide. The amount of this substance in the air is kept relatively constant not only by the production of carbon dioxide on the earth's surface, but by large amounts constantly escaping from its interior: and the ocean acts as a reservoir of carbon dioxide and a regulator of the amount in the air.

While the action of carbonic and other dilute acids benefits the plant by making plant food available, higher concentrations of acid may be injurious. As is well known, the acidity of the soil is a large factor in productiveness and some plants prefer acid soils while others show the opposite tendency. We are now in possession of a series of indicators which make it possible to ascertain various degrees of acidity found in soils without the labor of gas chain determinations, and these indicators may be used in the field.

An analysis of the factors of soil acidity is difficult on account of the many complications involved. Much aid may be expected from the application and extension of such careful quantitative studies as have recently been made on the ability of certain substances in solution to preserve the neutrality of the solution despite the addition of a considerable amount of acid or alkali to it.

To what extent the plant itself renders substances "available" by excretions from its roots is an unsolved problem. While it is generally agreed that the carbon dioxide excreted by the root is of importance in this respect, it is not certain whether other substances given out by the plant have a similar action. Investigation should be directed to the fatty acids which have been said by various observers to be excreted by the root. It is important to determine whether these substances are given off by the living or by the dead cells.

There can be no doubt that the bacteria of the soil help to render mineral food available by producing carbon dioxide. According to recent investigations the bacteria in one hectare of soil to the depth of 40 cm. produce yearly several million liters of carbon dioxide. Hence it becomes important in judging the fertility of a soil to test the amount of carbon dioxide which it produces under natural conditions.

The supply of available mineral salts is commonly augmented by the application of mineral fertilizers upon the theory that a deficiency in the supply of any necessary substance constitutes a "limiting factor" which retards the development of the crop. The addition of the deficient substance produces a great increase in the crop: the relation between this increase and the amount of salt added has been expressed by Mitscherlich in a simple formula having a constant which is independent of the yield. The constant for any given salt is called its efficiency value.

It is not my province to discuss this subject further and I will only mention that the application of one substance may set free a different one; for example, where magnesium is applied to the surface of the soil the roots at a lower level may receive, not magnesium, but calcium in soluble form (Hilgard). Sodium has been used in this way to set free potassium. Further study of this subject will doubtless bring to light facts of importance.

Some of the substances thus set free may exist in a loose combination to which the term adsorption has been applied. But it is clear that a variety of processes are included under this term. In the first place there are reversible processes, as when a dye is taken up by filter paper and is then completely washed out again by water. The rational formula which has been developed by Arrhenius for this process merits mention here.

Another process commonly called adsorption involves chemical change. An example is seen in the taking up of fuchsin from a watery solution by carbon: the fuchsin can not be washed off again by water, but is readily removed by alcohol. In this case the dye has been changed from a substance soluble in water to one insoluble in water but soluble in alcohol, which indicates the formation of an isomeric substance.

In other cases we may obtain the characteristic adsorption curve and yet be able to explain the phenomenon as a chemical reaction which involves no adsorption.

Numerous reactions take place in the soil which give the adsorption curve. The most important adsorbing substances are colloidal materials. Although colloids play a very important rôle in the soil, the rapidly accumulating discoveries in the field of colloidal phenomena have as yet found little application in soil studies. The use of the ultra microscope and of ultra filters capable of sorting out various grades of particles too small to be seen with the microscope, as well as the methods for measuring the rate of diffusion, the osmotic pressure, the viscosity and electrical properties of colloids, should find a place in the study of soil colloids. And we may expect important results from the application of the principles derived from the study of gel formation, of hysteresis, of the analogues of the Danysz effect, of temperature coefficients, of reaction velocity and similar fundamental matters which have proved fertile in the study of colloids. To speak of these in detail would take too much time. I will therefore mention only one.

According to the Gibbs-Thompson law substances which lower the surface tension tend to become more concentrated in the surface and reactions which produce such substances are favored at the surface. In the soil we deal almost entirely with surfaces, and it will be seen that the operation of this principle must promote such processes as oxidation and reduction where they tend to reduce surface tension and to retard them in the opposite case.

In the production of colloidal substances the organic materials in the soil play an important part. The great value of these substances is shown by the fact that good soil can be made without sand or clay but not without humus: fresh volcanic ash, consisting of finely ground minerals capable of furnishing plant food, must nevertheless await the admixture of humus before it can support crops.

Organic substances may combine chemically or mechanically with plant food and thus prevent it from being leached out of the soil.

Certain organic colloids are known to have a remarkable power of keeping difficultly soluble salts in solution at concentrations far above those which are possible in pure water. This consideration may prove important in soil studies.

The study of the organic substances in the soil is in a very backward state. It is known that some are beneficial and others are toxic and that in some cases the toxicity is partly removed by simple oxidation.

This leads us naturally to a consideration of oxidation in the soil. It is a striking fact that while some plants take up unoxidized substances and gain the energy they need by oxidizing them the majority of plants must have their food in a highly oxidized form in order to make the best use of it. Thus CO_2 is a food while CO is a poison: sulphates or nitrates are as a rule much better for the plant than the corresponding sulphites or nitrites. Most of the energy obtainable by oxidation of the latter substances is not available to the plant.

Thorough oxidation of the soil is one of the principal benefits of tillage and is a prime requisite for soil fertility: wherever it is interfered with by excess of water disastrous results follow, as may be seen in an extreme form in bogs. Investigations are being made on the oxygen content of bog waters and it is to be hoped that they may be extended to soil waters generally. Quantitative methods of estimating the rate of oxidation in soils under natural conditions are much to be desired.

The excretion of oxidizing and reducing catalyzers by living roots has recently been described and the statement has been made that the ability to oxidize such substances as gum guaiac (and to decompose hydrogen peroxide) is characteristic of good soil.

The study of catalyzers in the soil is a field in which we should have long since made a serious beginning. As I have just spoken of oxidation, an example from that field may be chosen to illustrate the point. It is well known that certain salts of manganese act as catalyzers which enormously increase oxidation, so much so that the minute traces of manganese which dissolve out from the glass vessels used in the experiment may affect the result. It is therefore possible that salts of manganese in the soil may affect fertility, and we may suppose that salts of iron and other substances may act in a similar way.

Another important field of study is found in the relation between those ions which are selected by the plant and those which it leaves in the solution. When the plant takes the K from a solution and leaves the Cl behind we have an illustration of this. The separation of positive from negative ions in this manner results in electric stresses which tend to bring the processes to a standstill. This may be overcome in two ways: first, the plant may give up to the solution some other positive ion in place of the K it takes in. It is evident that if such a process is taking place our usual view of the process of absorption neglects one of the most important factors of the process, and thus we should speak of an exchange rather than of absorption of ions.

On the other hand, we may find that along with every K ion the plant absorbs an OH ion derived from hydrolytic decomposition. If the plant should take the NO_3 ion and leave the Na we might find that along with every NO_3 ion the plant absorbed an H ion produced by hydrolytic decomposition. This amounts to saying that in all cases when the plant selects one ion and leaves the other it takes up the absorbed substance in the form of a very dilute acid or alkali. It is hoped that some investigations which are now going on may throw some light on this subject.

A further question concerns the manner in which ions which have been absorbed by the protoplasm are prevented from diffusing out again. It seems necessary to assume that only those ions which unite into undissociable compounds can be retained in the protoplasm. In this way we may explain how potassium, which presumably forms such compounds, may accumulate in the plant to a greater extent than sodium.

It may be pointed out that the chemical effects of soil substances on the plant may be of at least four kinds:

1. *Toxic Action.*—A large number of substances found in soils are toxic in sufficiently high concentration. This is true of both organic and inorganic substances.

It should be borne in mind that a concentration far too weak to affect one organism injuriously may be toxic for another. Concentrations of sodium chloride which are too low to affect certain flowering plants may be quite toxic to certain algæ and *vice versa.*

The study of such relations, especially in the case of organic soil substances, is now being carried forward.

2. *Stimulatory Action.*—A considerable number of toxic substances (including such salts as sodium chloride) exert at certain concentrations a stimulating effect on metabolism. It is quite possible that this belongs to the same category as the catalytic action of enzymes and of mineral salts. It also seems quite probable that the stimulating substances often play the rôle of kinases. How this may come about is illustrated by the germination of the castor bean. In this case it is necessary that the fat stored in the seed be split up by the action of an enzyme (lipase) but this can not act rapidly except in the presence of an acid (kinase). The rôle of the acid appears to be to cause the enzyme to swell and emulsify. The castor bean produces sufficient acid for this purpose, but it is clear that in other cases the kinase may be absorbed from without and may sometimes be furnished by another organism. There is reason to suppose that kinases include a great variety of substances, both organic and inorganic.

It is quite possible that stimulating substances may act in other ways, as, for example, by altering the permeability of the protoplasm.

3. *Nutrient Action.*—As was said in the beginning, we are not yet sure in all cases what nutrient substances are needed nor what their rôle is in the plant. To take but a single example we may select calcium. So important is it that we find plants classified ecologically into those which prefer lime soils and those which avoid them. A high authority very graphically describes how in the Mississippi Valley, in passing a region rich in lime to one where it is less abundant, the appearance of the trees changes: from being densely branched with thick foliage they become sparsely branched, so much so that the former region is avoided by squirrel hunters because the game can too easily hide in the dense tree tops. The crops become less and less, while barns and houses grow smaller as the soil grows poorer in lime.

Various hypotheses have been advanced to explain the effects of calcium. It was supposed to play an essential part in photosynthesis, but it appears that some of the lower green algæ may carry on photosynthesis in complete absence of calcium.

It was also supposed to form (in combination with proteid) an indispensable part of the nucleus, but many fungi and some of the algæ thrive without it, despite the fact that their nuclei and mitotic processes are apparently similar to those of plants which require calcium.

A more satisfactory view of this question is possible from the standpoint of protective action.

4. *Protective Action.*—It is well known that many toxic effects may be overcome more or less completely by the addition of other substances. When one substance thus acts as an antidote to another it is said to have a protective action. It is by no means necessary that the protective substance should itself be toxic, though it frequently is so; nor is it necessary that it should have any nutritive value. A large number of cases are now known in which mineral salts act as more or less efficient antidotes to other salts or to organic substances.

If we apply these principles to the case we have just now discussed, namely, the rôle of calcium, we shall see that they clear up many puzzles. As long as we try to explain all the benefits of lime merely as nutrient effects we can not account for its special importance. But as soon as we learn that lime is extraordinary in its *protective* action, which greatly surpasses that of all other substances in the soil, its importance becomes self-evident. This protective action is so great that a single calcium ion acts as an antidote to from 20 to 100 ions of sodium, potassium, ammonium, etc.

To make clear that this result may be quite apart from its nutritive action it may be mentioned that lime is unnecessary as a nutrient for many fungi, and the ordinary nutrient solutions for these plants are made up without it. But if the concentration of the nutrient solution be too high it becomes toxic: then the addition of lime overcomes this toxicity, without adding any nutrient, and makes an extraordinary increase in the growth of the plants.

The great importance of protective action has led to a number of attempts to explain how it is brought about. It was early suggested by Loeb that one salt may prevent the toxic action of another by preventing it from entering the cell. This suggestion has not been put to decisive experimental test until recently. The outcome is extremely satisfactory: it may be illustrated by the following typical case. *Spirogyra* placed in 0.1 M NaCl solution quickly died, but it lived a long time if a very small amount of $CaCl_2$ was added (1 molecule of $CaCl_2$ to each 100 molecules of NaCl). In order to find out whether the calcium hindered the sodium from entering the cell, the plants were placed in a solution of NaCl strong enough to produce plasmolysis. On observing them continuously under the microscope the cells were seen to recover from plasmolysis, the protoplasm expanding so as to completely fill the space inside the cell wall. This could only be interpreted as due to the penetration of NaCl, which thus raises the osmotic pressure within the cell. But if the *Spirogyra* be plasmolyzed in a solution of NaCl containing a little $CaCl_2$ (1 molecule of $CaCl_2$ to 100 molecules of NaCl) the recovery takes 10 hours instead of the half hour required when it is in pure NaCl. It is therefore obvious that the penetration of the NaCl is hindered by the presence of $CaCl_2$.

The same thing is shown by experiments on *Laminaria,* in which the rate of penetration of the ions of NaCl is directly measured by electrical means. Here the addition of a very little $CaCl_2$ hinders the penetration of the ions of NaCl in the most striking way.

It may be asked how merely delaying the entrance of a salt produces a beneficial effect. It is a well-known phenomenon that the sudden addition of a salt may produce precipitation of a colloid when the slow addition of the same amount produces no such effect. Similar facts are familiar in biology. Moreover, there is good evidence that when NaCl finally begins to penetrate the cell in a mixture of NaCl + $CaCl_2$ the $CaCl_2$ enters along with the NaCl; it may thus hinder the NaCl from entering various internal cell membranes (such as the nuclear membrane). It may also have other effects on the protoplasm.

We may therefore conclude that the mechanism of antagonism consists primarily in hindering the penetration of toxic substances, just as calcium hinders sodium from entering the cell. That the calcium does this by directly affecting the plasma membrane is shown by a variety of evidence which can not be described here.

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THE ORGANIC CONSTITUENTS OF SOILS[1]

The reports on the various phases of soil studies by the investigators who have preceded me in this symposium must have impressed you with the fact that the subject of the soil's fertility and infertility is by no means a simple matter of arithmetic, which involves only a few of the mineral constituents of the soil. It must also have become clear to you that the problem of the soil's fertility or infertility has not been solved by the application of these simple arithmetical means based on soil analysis or by the crop statistics accumulated in the years which have elapsed since Liebig first announced his views on soil fertility which gained for him for all time the title of "Father of Agricultural Chemistry." It is particularly gratifying to me, since I am to talk to you to-day on the subject of the organic constituents of soils, of their chemical nature and other properties, that Liebig is also known as the "Father of Organic Chemistry." To what tremendous proportions and significance in the world's industries and science this child of his (organic chemistry) has grown is familiar to all of you, and I assure you that Liebig, were he to return to-day, would be proud of its parentage. But I fear he would be displeased with his other child, as having made so little progress in the intervening years, although he started it in life strong and virile and full of promise. Up to a few years ago agriculture had not shared in the great impulses which modern science has given to other arts and industries, and the domination of the mineral requirement theory proposed in the first half of the last century and accepted without adequate proof of its validity is largely responsible for the lack of development in agriculture, commensurate with the enormous strides of other arts and industries under the guidance of modern scientific thought and research. But a new era of scientific inquiry is at hand and all phases of scientific endeavor are being applied to the solution of the problems connected with the soil's fertility and infertility—lines of scientific endeavor which were not even known to Liebig's time, but which to-day are well-recognized factors in soil fertility. I refer to soil bacteria, soil fungi, soil protozoa and other microorganisms, and all the biochemical functions of these, as well as of the higher plants, such as oxidation, reduction, enzymotic and catalytic, producing and destroying in the soil the organic constituents of which I shall speak presently. The soil is not simple, but complex. The soil properties and functions are likewise complex, not simple. All of the investigators preceding me in this symposium have emphasized to you by their papers how complex the subject is and how much remains to be done before a clear insight is obtained, but they have also shown to you clearly that a well-trained army of scientists is at work on the problems connected with soil fertility, applying thereto all the principles of modern science. The old view was simplicity itself; the soil was a mere trough in which the plant found its nourishment. But I can do no better than to let Liebig speak for himself. I quote from Letter XII. of his "Familiar Letters on Chemistry."

> A field in which we cultivate the same plant for several successive years becomes barren for that plant in a period varying with the nature of the soil; in one field it will be three, in another seven, in a third, twenty, in a fourth, a hundred years. One field bears wheat and no peas; another beans and turnips, but no tobacco; a third gives a plentiful crop of turnips, but will not bear clover. What is the reason that a field loses its fertility

[1] Presented at the Symposium on Soils at the Washington meeting of the American Association for the Advancement of Science.

for one plant, the same which at first flourished there? What is the reason one kind of plant succeeds in a field where another fails?

Liebig answered these questions by saying:

> Wheat, clover, turnips, for example, each require certain elements from the soil; they will not flourish where the appropriate elements are absent. Science teaches us what elements are essential to every species of plant by an analysis of their ashes. If, therefore, a soil is found wanting in any of these elements, we discover at once the cause of its barrenness and its removal may now be readily accomplished.

But has science removed the causes of the barrenness of a soil by the analysis of the soil or of the ashes of the plants? In this connection it might be well to quote a statement from an article by Coleman, which was awarded the prize of the Royal Agricultural Society of England in 1855. The author says:

> The causes which operate in producing the fertility or barrenness of soils have hitherto to a great extent been shrouded in mystery, not from any want of study, but owing to the difficulties which meet the inquirer at every step and the fact that most important results frequently depend upon causes which have eluded the search of the experimenter. The science of chemistry it was hoped would afford the key wherewith to unlock the mysteries of nature, but though its discoveries have conferred much practical benefit on the agriculturist, it has up to a very recent period effected comparatively little toward settling the cause of fertility or sterility. The theories of scientific men led us to expect that fertility depended upon the presence of certain mineral substances which were found invariably present in the ashes of plants, and the analysis of the soil it was believed would confirm the practical experience of the farmer; these hopes have been falsified except in the few cases of almost simple soils, such as pure clays and sands. In all other cases the analysis presented the existence in varying proportions of those substances supposed to induce fertility in the barren as well as in the fertile soil. The proportion of the various ingredients was next proposed as a sign of quality, but researches into the amount of inorganic matter abstracted by each crop have demonstrated that soils of a mixed character contain abundant supplies of mineral food for numerous crops.

This was over fifty years ago, and the statements made are practically as true to-day as they were then. There has been a marked advance in agricultural practise, but until quite recently comparatively little light has been shed upon the scientific principles which underlie these practises.

In all justness to Liebig, however, rather than to his followers, I must make another quotation from his works to show that he himself recognized the insufficiency of the views expressed by the above quotations. He says:

> But it has been observed that the crops are not always abundant in proportion to the quantity of manure employed, even though it may have been of the most powerful kind; that the produce of many plants, for example, diminishes in spite of the apparent replacement by manures of the substances removed from the soil, when they are cultivated on the same field for several years in succession.

From the above quotation it may be seen that Liebig recognized that there are many cases which his theory of mineral requirement failed to cover. Indeed, if he had followed the idea embodied in the quotation to its logical analysis he would have reached some conclusions similar to those presented to you in the various papers to-day.

Even before, and especially since, the time of Liebig, much material of the kind presented to you by the preceding speaker has been accumulated and handled in the same statistical manner. I should here say that much valuable information has been thus obtained, but it should be needless for me to add that even with all these years of crop statistics at hand the difficult problems of the cause of fertility or infertility of our agricultural lands have not been thereby determined nor eliminated, as is again emphasized by what the other speakers have told you. The problem is not solved, though much progress has been made through the application of modern science. If the problem of soil fertility had been solved by the application of such statistics this symposium would not have been held. The pessimistic views expressed I can not share. Science is ever optimistic; the scientific investigator must above all things be optimistic and have an abiding faith that science will solve the intricate questions connected with his problem. The problem of soil fertility and infertility is broad enough and big enough for many workers and methods of attack. We can not all begin to unravel the tangled threads at the same point; there are different viewpoints and it is not improbable that some may have a keener vision than others to see the particular thread that will undo the snarl. The solution of the problem can only be reached through results of diligent experimentation, not by the statistics of even a hundred years. Criticism of the Bureau of Soils, similar to the present one, have recurred frequently in the past few years, as you are aware; but nevertheless the Bureau of Soils has continued its work from the new viewpoint and achieved some important results which throw much light upon the dark subject of the cause of fertility and infertility of our agricultural lands. I am very glad of this opportunity to present to you the results of a phase of this investigation, namely, the importance of the organic constituents of soils.

I have brought with me a tangible result of this work in the form of specimens of the organic compounds which have been found in soils. Their isolation and identification give definite information about a portion, and a very important portion, of the soil, the value of which has been recognized in practise, but about which no definite information was at hand, until this work was undertaken. By the application of modern methods of research to the intricate problems of the soil we have been able to throw such light upon the biochemical changes in soils that the old views of soil organic matter, soil humus and the process of humification are entirely overthrown. The compounds of which Mulder, the contemporary of Liebig, writes, such as humic acid, geic acid, ulmic acid, etc., terms which have appeared in text-books ever since, have absolutely no existence, but are shown to be mixtures of many different, and widely different, compounds. Not only were the compounds contained in these specimen tubes not known as soil constituents to Mulder or Liebig, but they were unknown to science at that time. With the advance of science since that time, especially of biochemistry, results such as these have been made possible. Some of these compounds contain only carbon and hydrogen; some, carbon, hydrogen and oxygen; some, carbon, hydrogen, oxygen and nitrogen; and some, carbon, hydrogen, oxygen, nitrogen and phosphorus. The compounds represent a great variety of chemical classes; there are paraffin hydrocarbons, hydroxyfatty acids and other organic acids, esters and alcohols, carbohydrates, hexone bases, pyrimidine derivatives, purine bases and pyridine derivatives. The individual compounds isolated or found are as follows:

ORGANIC COMPOUNDS ISOLATED AND IDENTIFIED

Hentriacontane,	Phytosterol,
Paraffinic acid,	Liquid glycerides,
Lignoceric acid,	Picoline carboxylic acid,
Agroceric acid,	Nucleic acid,
Monohydroxystearic acid,	Cytosine,
Dihydroxystearic acid,	Xanthine,
Resin,	Hypoxanthine,
Resin acids,	Adenine,
Resin esters,	Histidine,
Pentosan,	Arginine,

Pentose,	Choline,
Agrosterol,	Creatinine.

In addition to those here mentioned, a number of others are already isolated and will soon be reported. It is obvious that definite chemical information of this kind sheds much light upon the nature of soil organic matter and the processes going on in the soils. The compounds encountered are the same as those encountered in other lines of biochemistry and, therefore, the knowledge in regard to chemical relationships, origin and processes of change accumulated in such other lines can be directly applied to the understanding of the biochemical changes in soils and the constitution of soil organic matter. It is not my purpose to discuss the biochemical changes here other than to say, in passing, that the occurrence of these products which have an obvious chemical relationship with the great classes of tissue material contained in the plant and animal débris that gets into the soil, the carbohydrates, the fats, the proteins, the nucleic acids, the lecithins, etc., proves conclusively that the process of humification is not a mysterious process which takes place in soils only and can not be understood, but rather that the process of change in the soil is, after all, very closely paralleled by the processes known to take place in the laboratory when the complex organic substances are split by hydrolysis, oxidation, reduction or deamidization, into simpler derivatives. It is my purpose, however, to bring strongly before you the fact that these soil constituents affect plants directly.

As scientists personally interested in all that has to do with plant life and development, you will be glad to learn that we have studied as many as possible of these compounds in such a way as to determine what their possible function in the soil may be. Indeed, the reason why this investigation of the organic matter in soils was undertaken is to be found in the fact that certain soils and soil extracts behaved toward plants as if they contained something detrimental to crops rather than an absence or deficiency of the usual beneficial elements like nitrogen, phosphorus or potassium. This harmful effect on plant growth can be shown very readily by any one with such a soil under investigation. The soil is shaken with distilled water for several minutes, allowed to settle, and the supernatant liquid filtered off, which must usually be done with a Pasteur-Chamberland filter in an apparatus specially designed for such work, in order that all solid material may be removed. The clear filtrate is then used as a medium for the growth of wheat seedlings in bottle cultures. A control in pure distilled water, or in an extract from a fertile soil, should be run at the same time. In such cases the plants grown in the extract from the poor soil will show many peculiarities not shown by the plants either in the pure distilled water or in the extract from the good soil. The plant will be smaller, less developed in top and root, the latter often showing dark and swollen tips, which are sometimes bent into hooks, a phenomenon characteristic of certain toxic action. The growth in this soil extract may even be greatly less than the growth in the distilled water, although the soil extract naturally contains plant nutrients, whereas the distilled water contains none.

If a separate portion of the original extract be treated with carbon black, made from natural gas by imperfect combustion much as lampblack is formed on lamp chimneys, agitated and filtered, the filtrate will be a good medium for the growth of the seedlings. This simple treatment with carbon black has, therefore, removed by absorption the harmful properties of the soil extract and the growth is now even better than in the distilled water.

Another experiment with soil and carbon black was made as follows: A layer of moist carbon black was covered with a layer of moist unproductive soil and this in turn by a layer of moist carbon black. In this experiment the moisture could circulate from the soil to the carbon black and back again and thus gradually the soil fluid would be freed of any injurious compounds by absorption into the carbon black. At the end of a day or two of this interaction the soil was freed from the carbon layers, plants were grown in it, and when compared with soil not so treated a very marked improvement was shown, again indicating that a harmful body was originally present and had been removed in whole or in part by this carbon black treatment.

Observations of this kind on many soils, together with a study of the properties of the material dissolved in the water, led to no definite isolation of the compound or compounds showing the harmful effect, owing to the fact that the quantities in the water extract are too small for identification, but they did lead to a recognition that the substances were not mineral in character, but were constituents of the organic matter of the soils.

That organic substances could produce such effects in such small quantities as must be present in soil solutions was not apparent from the literature and it became necessary to establish this point. With this in view, a test of about forty substances of organic origin which may get into the soil or be formed therein were tested, and it was conclusively shown that a number of these were decidedly harmful to plants, even in very dilute solutions comparable with the organic content of soil solutions.

It therefore became essential to make a study of the organic matter of the soil. The organic matter of the soil, however, was a subject about which the older chemistry of agriculture had much to say, but in regard to which modern science was discreetly silent. With no established facts and no methods of attack worked out, progress was necessarily slow at first, but gained speed with each compound isolated or identified until to-day there have been isolated in these laboratories more than twenty-five definite compounds from soil organic matter and the work is progressing at a rapid pace.

The search for this supposedly harmful constituent was rewarded by the discovery, among others, of dihydroxystearic acid, a compound which, on account of its frequent occurrence in soils, has been rather thoroughly studied in regard to its effect on plant development and growth.

The isolated and purified dihydroxystearic acid was tested by dissolving it in pure distilled water and it was found to have decided deleterious action on the wheat seedlings used in the tests. The acid prepared in the laboratory behaved in the same manner.

Its effect in the presence of nutrient salts was also extensively studied in solutions containing calcium acid phosphate, sodium nitrate and potassium sulphate, alone and in combinations of two and three of these salts, a total of sixty-six cultures being used in a single test. The injurious effect of the dihydroxystearic acid was less where all three of the nutrient elements were present than where only one or two were present. The injurious effect was least in those cultures of three nutrients where the nitrate was high. This indicates that the action of the nitrate tends especially to overcome the harmful effect of the compound or else it enables the plant to resist or overcome its effect.

Dihydroxystearic acid has another effect which should here be mentioned as having a considerable bearing on its effect on crops, even in such soils as contain much plant nutrient material in the most readily available form. This is its influence on the absorptive power of the roots of the plants growing in the soil, the soil solution, or solutions of nutrient salts when dihydroxystearic acid is present in them. The absorption of potassium and phosphate was greatly interfered with, although both were present in soluble form in the culture solutions; only the nitrate was consumed in any quantity. This is in harmony with the fact stated above that when nitrates were plentiful in the solutions, the best growth was obtained and the effect of the harmful compound was minimized or entirely overcome.

The occurrence of dihydroxystearic acid was specifically studied. For this purpose soil samples of good and poor fields were collected and examined for this constituent. Soils from eighteen different states, extending from Maine to Oregon, and southward to Texas, of widely different origin, topography, texture, climate, drainage and cropping, varying from soils of the highest productivity to soils incapable of producing profitable crops, were examined for dihydroxystearic acid.

One third of all the soils examined showed the presence of this compound. It was found in virgin soils as well as in soils under long cultivation; in soils continually cropped as well as in soils under permanent sod; in soils from the Atlantic coast; in soils from the Pacific coast; and in soils from the gulf states. This compound is, therefore, a common soil constituent and is likely to be encountered in soils anywhere. Its formation or its accumulation is doubtless due to local conditions in any one section, but those local soil conditions are not confined to any region of the United States and probably not to any country or continent.

When the soils examined are separated into good and poor soils, as based on field observations, their relationship with dihydroxystearic acid is rather striking. Among the good soils only two contained dihydroxystearic acid and they were of only moderate productivity. Among the poor soils the number of those containing this compound was approximately one half. Of the soils which had a definite record for infertility, the dihydroxystearic acid was found in each and every case.

Judging from the foregoing relationships established by this investigation it would seem that dihydroxystearic acid is either a direct or indirect factor in the low productivity in soils; direct by virtue of its harmful effects on growing crops, indirect as an indicator of other compounds or conditions which cause soil to become less productive and even infertile. It is not possible to state from the data at hand that dihydroxystearic acid is the only factor which contributes to the infertility or unproductivity in those soils in which it was found, for it must be remembered that this is only one of many compounds, both organic and inorganic, harmful and beneficial, as I shall show presently, which exist in soils, any and all of which play a part in its relative fertility and infertility. It is certain, however, that the determination of even this one constituent leads to a recognition of the kind of infertility in the soils examined and is, therefore, a readily recognized symptomatic factor of poor soil conditions.

The isolation of harmful constituents is, however, only a part of the entire field covered by these investigations into the nature and properties of soil organic matter, and I am very glad to be able to announce to you the existence in the soil of organic compounds decidedly beneficial to plant growth. Here is, for instance, a specimen of creatinine, a nitrogenous compound, which we have isolated from soils. This compound has always been associated with animal material, but in addition to finding it in soils we have also found it to exist in many plant materials, for instance, in wheat seeds, wheat seedlings, wheat bran, in rye, clover, alfalfa, cowpeas and potatoes, and if, as is suggested by several investigators, creatinine in the animal arises as the result of the breaking up of albumen, then it seems reasonable to expect that creatinine would be found in practically all plants. From the standpoint of root excretion I should also mention the fact that of samples of the same soil planted and unplanted, the planted soils give larger amounts of creatinine, thus showing that the increase of creatinine in the soil is connected in some way with plant growth. When the roots of wheat were bathed in water the creatinine could also be found in the culture water. One of the sources of creatinine in soils would, therefore, seem to be found in the presence of this compound in plants, since by the decay of plants and by direct sloughing or even by excretion, the creatinine is left in water and soil. Its occurrence in stable manure and also in green manures is another source, and its formation by soil organisms may be another. Whatever its source, it occurs in soils, and appears to be a normal and frequently occurring constituent and is present in amounts comparable with the amounts of soil nitrates found in ordinary agricultural soils. Its effect on plants, as I have implied earlier, is decidedly beneficial. When a series of cultures containing only potash and phosphates in varying proportions is set up together with another set containing in addition some fifty parts per million of the creatinine, the increased growth in the latter set is rather striking, fully comparable with the increased growth produced by nitrates under the same circumstances. When nitrates are present at the same time, the additional effect of the creatinine is not so marked, but an analysis of the culture solution reveals the fact that far less nitrates are used by the plants in the presence of the creatinine, although a larger plant growth takes place. In other words, the plants absorb the creatinine, make use of it in building up tissue, and in so doing a diminished draft is made on the supply of nitrates. It appears, therefore, that this soil constituent is fully as valuable as soil nitrate, can be present in amounts comparable to the amount of nitrate in soils and is able to replace the latter in its effect on plant growth. The significance of this to agricultural investigations is apparent.

Nor is creatinine the only constituent that behaves in this manner. The same beneficial characters are shown by other soil constituents, by the hypoxanthine and xanthine, by arginine and histidine and by nucleic acid. All these show the same beneficial character on plant growth and the same effect on the decreased nitrate consumption. Based on the results of these rather extensive investigations, I am ready to formulate the theory that these degradation products of protein are absorbed directly by the plant from the soil and that the plant uses these units for building up the complex proteins as far as it is possible to do so. Nitrate is usually considered as the best form of nitrogen for plant food. In order to use nitrate, a highly oxidized form of nitrogen, to form the amido and imido groups of the protein molecules, a reduction must take place.

It is obvious that the plant must spend considerable energy in making this transformation. What is more reasonable than to suppose that the unit parts of the complex protein molecules, when presented to the plant, will be used by it in preference to expending labor on the nitrate to prepare these units? If a soil be liberally supplied with all of these units, it is conceivable that good plant growth will result, even without nitrate. If only a limited amount or kind of the units be present, the plant must have nitrates with which to supply the missing units. The knowledge, therefore, that such compounds exist in soils and play such a prominent part in the metabolism of the growing plant is of fundamental significance in soil fertility and gives a breadth of view to the subject which in its horizon can not be compared with the restricted vision imposed by the purely mineral requirement theory of Liebig, as this is used by his followers.

Nitrates are not produced in these cultures. Ammonia if formed is insignificant in amount, nor does ammonia produce the striking results shown by these organic compounds. There is a limit to the amount of any one of these soil constituents which the plant can profitably use and show increased growth. When a mixture of several of these units is presented at once, the growth is better than if an equivalent or even larger amount of any single one is presented.

These compounds are nitrogenous, but it must not be inferred that all nitrogenous compounds are beneficial to plant growth. Tyrosine, also a degradation product of protein, is distinctly harmful, and picoline carboxylic acid, isolated from soils, is moderately toxic. Guanidine, a compound not yet isolated from soils but whose presence is indicated, has also been rather thoroughly studied, and is decidedly harmful to plants, producing an effect on the cultures similar to that shown by certain plant diseases. The leaves become spotted with bleached dots, which spread and ultimately coalesce, producing a wilting of the plant and finally death. Not only is the guanidine harmful, in contradistinction to the beneficial nitrogenous substances just discussed, but it also differs from these compounds in its behavior when nitrates are present. The latter fertilizer ingredient very greatly increases the toxic action of this compound. This is especially striking when a large series of cultures with and without guanidine in the presence of many ratios of phosphate, potash and nitrate is set up and the cultures arranged according to the nitrate content. Both groups of cultures with and without guanidine will grow nicely for three or four days without any peculiarity being noticeable in either group. The cultures high in nitrates will be the first to show the symptoms of guanidine poisoning, and this effect will spread through the guanidine group of cultures, becoming more and more marked in those high in nitrates. At the conclusion of two weeks the group of cultures containing no guanidine will appear green and fresh, whereas the guanidine group appears bleached and wilted in all of the cultures containing nitrates. The cultures which contain no nitrate, that is, only potash and phosphate, are the only cultures which have been able to withstand the ravages of this poisonous compound. We have here a striking illustration not only of the harmful effect of an organic nitrogenous compound, but also an example of the increased harmful effect brought about by the addition of the otherwise so beneficial nitrate. This is in strong contrast to the ameliorating effect of nitrates over all other fertilizers in the case of the harmful soil constituent, dihydroxystearic acid. Guanidine is harmful and dihydroxystearic acid is harmful, although this manifests itself in a different way. Nitrate increases the harmfulness of guanidine, but decreases the harmfulness of dihydroxystearic acid. Here is an effect of a fertilizer which is entirely unexplainable from the viewpoint of mineral requirement or plant-food addition.

Nor is this behavior of nitrate in influencing the effect of these organic substances on plant growth and development the only illustration of the influence that different fertilizer salts can exert on the action of the organic compounds on plants. Cumarin is another substance which we have studied quite thoroughly in its effect on wheat seedlings. Besides decreasing growth, it also has a very peculiar and characteristic action on plants which enables the experimenter to pick out cumarin-affected plants at a glance from those affected by any other toxic body studied by us. The leaves are shorter and broader than is normal for wheat and only the first leaves are usually unfolded, the other leaves remaining wholly or partially within the swollen sheath. Such leaves as do break forth are usually distorted and curled or twisted. Now when cumarin is contained in the culture solutions of the various fertilizer salts, it is quite apparent that neither nitrate or potash nor combinations of these affect these characteristic symptoms of cumarin poisoning, but the slightest addition of phosphate causes a very decided change in the appearance of the plants, which increases with increasing phosphate until nearly normal development is obtained, as shown by comparison with the corresponding cultures without cumarin.

I must also cite to you the influence of quinone when similarly studied. The effect of quinone is decidedly different from the effect of cumarin, which produced short, broad, irregularly developed leaves and stunted tops; the effect of quinone is to produce long thin leaves, and tall slender plants. The interesting part in this connection, however, lies in the fact that the growth in the cultures high in potash was nearer to the normal than the growth in either the mainly phosphatic or mainly nitrogenous cultures, and was in fact poorest in the latter. Vanillin similarly studied behaved like the dihydroxystearic acid in that nitrates were the most efficient aid to counteract its harmful effect on plants.

These experimental facts present much interesting material for discussion from various points of view, but I wish here only to call your attention to the relations between organic compounds, their effect on plants, and the action of fertilizers in this connection, which action is apparently apart and in addition to any food value of the fertilizer salts for plants in the usually accepted sense. It is clear that in the illustrations which I have here given you, the various fertilizer salts acted differently in overcoming the respective harmful effects of these toxic organic compounds. The mainly phosphatic fertilizers were the most efficient in overcoming cumarin effects; the mainly potassic in overcoming the quinone effects; the mainly nitrogenous fertilizers in overcoming the vanillin and dihydroxystearic acid effects; and in the case of guanidine, the mainly nitrogenous fertilizers even had the effect of increasing the harmfulness of this compound. It is clear that the organic compounds in soils, whether already isolated and studied or yet to be found, are potent factors in soil fertility as they have a direct effect on plant growth and plant metabolism and on the action of fertilizers. These actions of the different fertilizer combinations or different fertilizer requirements, as they may be styled, show a certain parallelism with field observations on soils and their fertilizer requirements, and one is tempted to ask to what extent the different fertilizer requirements of different soils, or of the same soil under different conditions, may be influenced by the same cause. That harmful bodies occur in soils has been amply shown and that these are influenced directly or indirectly by fertilizer salts is also clear from these and other researches. That the constitution of the organic matter varies from soil to soil and in the same soil under different conditions of aeration, drainage and cropping is likewise clear. The presence of compounds inimical to plant growth by virtue of a property resembling that of any of the above-mentioned substances might, therefore, cause a different fertilizer requirement, a requirement which might even change from time to time, according to the nature of the biochemical relations producing the body or according to the nature of the plant remains in the soil; in other words, according to the rotation, with its necessarily altered soil management, and the altered biochemical changes produced in the different plant remains.

The soil has vital functions. The soil can not be considered as the dead, inert remains of rocks and previous vegetation, but must be considered as an accumulation of such material in which the process of formation, alteration and transposition are still at work. In other words, the soil in its entirety is not dead or inert, but endowed with functions analogous to those of life itself. In it take place the same processes of solution and deposition that have taken place in past ages, and are taking place to-day in the geologic processes connected with the action of the water on the rocks and minerals of the earth's crust. In it take place the same physical and chemical interactions as take place in the movement of subsurface waters generally, resulting in ore formations or depositions. In it take place the same processes of fermentation, digestion, or decay of organic materials as take place in animals and plants or in the production of industrial products, such as cheeses, wines and beers, brought about in the soil as in these other processes by means of ferments, enzymes, bacteria and fungi or molds. In it take place the same processes of oxidation and reduction which play so enormous a part in all life processes, and these researches have shown the nature of compounds in the soil organic matter to be the same as those derived from such life processes or from similar laboratory processes of digestion, oxidation or reduction. Organic matter is very changeable; it is the material which forms the food, as it were, of all the microorganisms of the soil, of the bacteria, of the molds, of the protozoa, and influences them favorably or unfavorably, just as the higher plants are affected. In turn these agents are great promoters of these changes in the organic débris of soil. All of these processes and the life forms in the soil are affected by fertilizer salts when added to the soil, and changes are produced in the soil, physical, chemical and biochemical, which influence the soil and affect its potential fertility entirely irrespective of the added plant food. In other words, the soil has been changed in many prominent characteristics even before any crop is planted therein.

I must not leave this subject of fertilizer action, in view of the preceding paper, without saying that the Bureau of Soils takes an advanced stand not only on the present use of fertilizers, but on their extension in agriculture, in spite of the reiterated statements to the contrary. The point of difference lies in the explanation of their action, the one view being that they are merely so much plant food which must replace the removal by crops, the other being that in addition to any plant food value which they possess, they affect the soil and produce changes and influences such as are at least partially illustrated by the experimental results cited here. We believe that these additional—note particularly that I say additional—actions explain more fully the function of fertilizers in agriculture. From the former view the application of fertilizers would be restricted to poor and so-called exhausted soils and poor systems of agriculture; from the latter viewpoint, fertilizers are indicated as well for fertile as for infertile soils, as an adjunct to successful farming and bringing the soil to its highest capacity of crop production.

The action of fertilizers on soils is a much contested question, but the weight of evidence is against the assumption that their effect is due altogether to the increase of plant food as such. If so simple an explanation were the true one, nearly a century of investigation of this problem by scientists of all civilized nations would surely have produced greater unanimity of opinion than now exists in regard to fertilizer practise. Thoughtful investigators everywhere are finding that fertilizer salts are influencing many factors which contribute toward plant production besides the direct nutrient factor for the plant. It is this additional influence of fertilizers which makes them doubly effective when rightly used and inefficient when improperly used. To this influence of fertilizers on soil and biological conditions is due their capriciousness when applied on the theory of lacking plant food, and any study which throws further light upon the mooted question is of direct help toward reaching that view of soil fertility and soil fertilization which will eventually result in a more definite, more rational and more remunerative fertilizer practise than in the past, and thus bring about the more extensive use of fertilizers in agriculture.

Oswald Schreiner
Bureau of Soils,
Washington, D. C.

THE DRIFT IN SECONDARY EDUCATION

In the course of a preliminary study of the conditions affecting a particular high-school subject, I have been led to glean from the reports of the Commissioner of Education data which, tabulated or represented graphically, may have a certain interest.

The table has to do with the expansion of secondary education, 1890–1910. It is self-explanatory, but one or two points in it may be noted. First, while the population of the continental United States has increased 50 per cent. the proportion of the population in the secondary schools has been multiplied by about *three*. Second, that while the proportion of students completing the secondary course and graduating has slightly but decidedly increased, the proportion of them preparing for college, either classical or scientific courses, has been diminished by about 60 per cent. Third, that the proportion of boys in the secondary schools has in twenty years not varied much from 44 per cent.; also, that the proportion of boys in the successive years falls off somewhat, but not as largely as I had been supposing; in fact, the "elimination" of girls goes on at almost as rapid a rate as that of boys. Finally, that while the amelioration of conditions as shown by the number of students per teacher is noticeable, the burden placed upon the teacher in small high schools is in this respect markedly less than in those in cities of 8,000 inhabitants or more, and in these small schools the improvement is much greater. Of course, specialization in teaching tends in some degree to counteract this.

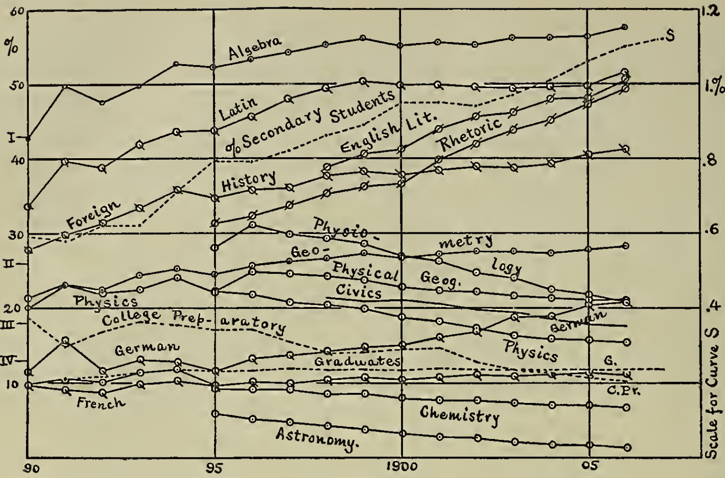

Chart I.

THE EXPANSION OF SECONDARY EDUCATION[1]

	1890	1900	1910
Population of U. S., millions	62.622	75.063	91.972
Number of public high schools reporting	2,526	6,005	10,213
Number of other sec. schools reporting	1,632	1,978	1,657
Number of secondary pupils	367,003	719,241	1,131,466
Percentage of boys, secondary pupils	45.03	43.16	43.97
Percentage of population, sec. pupils	0.59	0.95	1.23
Percentage of high school pupils, urban	—	45.3	47.3
		(1906–7)	
Percentage of high school pupils, yr. I	—	(42.35)	42.09
Percentage of these boys in yr. I	—	(44.2)	45.6
Percentage of high school pupils, yr. II	—	(27.23)	27.10
Percentage of these boys in yr. II	—	(42.6)	43.3
Percentage of high school pupils, yr. III	—	(18.17)	18.18
Percentage of these boys in yr. III	—	(41.6)	41.8
Percentage of high school pupils, yr. IV	—	(12.25)	12.63
Percentage of these boys in yr. IV	—	(40.2)	39.7
Percentage secondary pupils graduating	10.05	11.74	12.18
Percentage of these boys	—	—	40.3
Percentage preparing for College	18.66	14.53	6.80
Urban high schools—number	—	691	838
(In cities of 8,000 or over.)			
Teachers per school	—	11.4	19.0
Students per school	—	340.3	516.3
Students per teacher	—	29.9	27.1
Rural high schools—number	—	5,314	9,375
Teachers per school	—	2.4	2.7
Students per school	—	53.5	51.5
Students per teacher	—	22.7	18.8

[1] Extracted from the reports of the Bureau of Education.

Chart I. gives graphically the history of the decline in scientific studies as compared with humanistic, from 1900 to 1906. It was accidentally omitted from its proper place as illustrating a previous article.[2] Besides show-

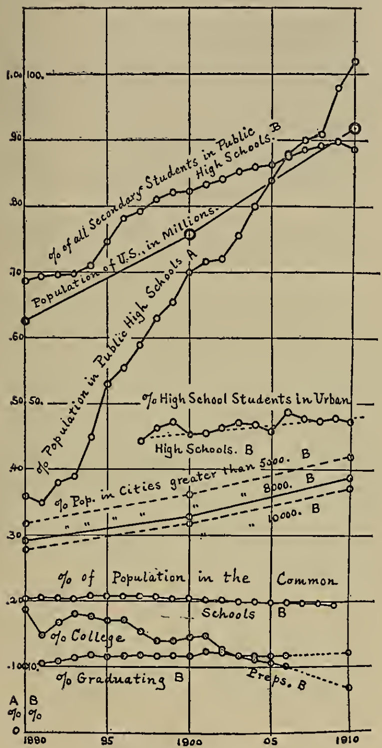

CHART II.

ing this decline in a striking way, the dotted curves show also the facts about the proportion of secondary students to population, and the proportion of graduates and college preparatory students to the whole mass of students. The points marked I., II., etc., at the left, indicate the approximate proportions of secondary students in the first, second, etc., years of the course. The decline of science indicated up to 1906 is continued in 1910, though not plotted.

Chart II. is for the most part self explanatory. It shows again the facts about population, graduates and college preparatory students, and adds data about some other interesting relations. The highest curve of all shows the extent to which public high schools are monopolizing the work of secondary education. The curve for per cent. of population in the common schools shows that, contrary to the tendency in secondary education, this ratio tends to diminish, though not varying much from 20 per cent. But the group of curves relating to urban high schools and urban population develops a fact of considerable interest. The two dotted curves are taken from census data; the heavy curve between them is partly interpolated. They give the proportion of urban to total population. The curve above them shows what proportion of the high-school population attends school in places of 8,000 or more. This latter proportion has increased irregularly from about 44 per cent. in 1897 to a little over 47 per cent. in 1910. This is clearly seen to be less than the rate of increase of urban population, so that in some fifteen years the cities of 8,000 or over will have only their share of the high-school population—the country high schools are catching up to the city. Of course the drift toward industrial education will certainly largely modify our classifications in the next decade; but in what way can not now be concluded.

Chart III. shows to what extent we may find local influences hidden under general averages. The data are taken from the report for 1910. The black dots are points representing conditions in the old slave states; the crosses stand for the New England states—no longer *Yankee* states. The dotted lines represent averages for the United States. The plotted points group themselves so as to show, as no table could, that where the number of secondary students per thousand of population

[1] SCIENCE, 35, p. 94, 1912: "Is Science Really Unpopular in High Schools?"

is small, there the proportion of secondary students pursuing algebra tends to be large. One is reminded of Booker Washington's remark about the freedman's penchant for studying Latin and holding office—but the

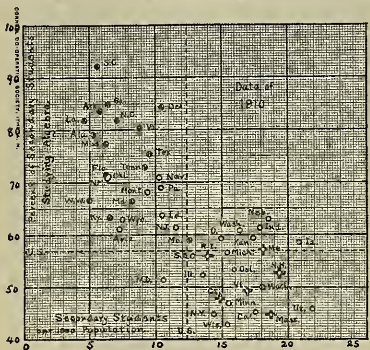

Chart III.

black dots on the chart represent mainly white education.

The method of this last chart may be applied as well to other studies and to the percentage strength of the various years of the course, all of which are shown to be more or less strongly related to the number of students per thousand of population. An attempt to correlate these statistics with urban congestion has, however, failed, as urban density so crosses state educational systems, and counts for so much more in some states—as Rhode Island—than in others, that a satisfactory disentanglement of the relations is practically impossible.

I would draw one general conclusion from this study. Our impressions of secondary—and other—education are strongest as they are derived from our own experience as students. Most college and university men, even those who have the closest relations with the work of the secondary schools, have done little actual secondary school teaching, and hence are very likely to be strongly under the influence of impressions received twenty, thirty or more years ago. Such impressions are, however, nearly valueless as guides in dealing with the present situation. The tabular and graphical representations of statistical facts show at a glance that since 1890 the problem of the secondary school has changed from that of the fitting school to one of a decidedly non-fitting school—some bigots would say a decidedly *unfitting* school; a school in which only 6.8 per cent. of the pupils anticipate college work of any sort. This being the case, the colleges and universities can not lead the way in the fashion of 1892 and the Committee of Ten; the problems of secondary education can be solved only in the schools.

Willard J. Fisher

Ithaca, N. Y.,
June, 1912

SCIENTIFIC NOTES AND NEWS

The American Society of Naturalists will meet at Cleveland on January 1 and 2, 1913. The session on January 1 will be given to the reading of papers on genetics, and that of January 2 to a symposium on adaptation. The annual dinner, open to members of the affiliated societies, will be held on the evening of the second, with the president's address by Professor E. G. Conklin.

The American Society of Zoologists will hold a joint meeting of its eastern and central branches in conjunction with the meeting of the American Association for the Advancement of Science at Cleveland, Ohio, during convocation week. Notice of this meeting, together with a request for the titles of papers to be presented, will shortly be sent to all members. Communications from members of both branches should be addressed to Professor Winterton C. Curtis, University of Missouri, Columbia, Mo., the secretary of the Central Branch, since the constitution provides that "the meetings of the societies shall be arranged for and conducted by the officers of that branch in whose territory the meeting is held." The president of the Central Branch during the current year is Professor Henry B. Ward, of the University of Illinois, Urbana, Ill.

A joint meeting of the American Anthropological Association, the American Folk-Lore Society and Section H of the American Association for the Advancement of Science will be held in Cleveland, Ohio, on December 30, 1912, to January 4, 1913. Titles of papers to be read and abstracts of the same should be sent by December 1 to Professor George Grant MacCurdy, Yale University Museum, New Haven, Conn., who is responsible for the joint program.

The Association of American Universities will hold its annual meeting at the University of Pennsylvania on November 7, 8, and 9, 1912.

Professor Bergson, of Paris; Professor De Vries, of the University of Amsterdam, and Sir William Ramsay, of London, have been appointed Woodward lecturers at Yale University.

Dr. Felix Krueger, professor of philosophy and psychology at Halle, who is this year's Kaiser Wilhelm professor at Columbia University, delivered his inaugural lecture on October 29. His subject was "New Aims and Tendencies in Psychology."

Professor Emile Borel, director of scientific studies at the École Normale Supérieure and professor of the theory of function at the University of Paris, will lecture at Princeton University on November 6.

Professor Jorge Engerrand, of the City of Mexico, has been designated honorary professor in the New University of Brussels. The Mexican government has appointed him to the directorship for 1912–13 of the International School of Archeology and Ethnology, recently founded in the City of Mexico. In this latter capacity Professor Engerrand's work will deal largely with the antiquity of man in America and especially from the geological standpoint.

Professor John E. Sweet, formerly professor of practical mechanics in Cornell University, was eighty years old on October 21, and some of his former students gave him a banquet at the Onondaga Hotel in Syracuse on that night.

Dr. Mazyck P. Ravenel, head of the state hygienic laboratory at the University of Wisconsin, has been appointed first lieutenant in the medical reserve corps of the United States Army by President Taft.

At the Nutrition Laboratory of the Carnegie Institution Dr. Raymond Dodge, professor of psychology at Wesleyan University, Middletown, Conn., has been appointed consulting experimental psychologist, and an especial laboratory has been equipped for his investigation. Dr. Sergius Morgulis, Sheldon fellow of Harvard University during the year 1911–12, and who has engaged in investigation in the laboratory of Professor Zuntz, of Berlin, has been appointed associate in animal metabolism.

M. F. Smith, B.S. (Yale, '97), has been appointed assistant astronomer at the Yale University Observatory.

Dr. Charles Porter Small, who has been the university physician since the founding of the University of Chicago, has resigned to devote his entire time to private practise.

At the last meeting of the Rumford Committee of the American Academy of Arts and Sciences a grant of $250 was made to Mr. W. O. Sawtelle, of the Jefferson Physical Laboratory, Harvard University, in aid of his research on the spectra of the light from the spark in the oscillatory discharge.

Professor Wm. T. Magruder has resumed his duties as head of the department of mechanical engineering in the Ohio State University after a year's leave of absence. Professor Magruder spent a considerable part of the year in travel through Europe, investigating the trades schools. He has recently been elected president of the Society for the Promotion of Engineering Education.

The Rev. José Algué, director of the Manila Observatory, P. I., is now in this country and is making his headquarters at Georgetown University, of whose observatory he was formerly director.

Dr. Krusius, dozent at Marburg, has undertaken, with the support of the Prussian and

Bavarian governments, a ten-months' trip to foreign countries, to repeat on different races the investigations on myopia in the schools which he began some time ago in the province of Brandenburg.

Mr. S. W. Foster, who for the past six years has been engaged in deciduous fruit insect investigations for the U. S. Bureau of Entomology, is now engaged in the research and applied work on the Pacific Coast with headquarters in San Francisco.

Mr. Robert C. Murphy is in charge of an expedition to the South Georgia Islands, under the joint auspices of the Museum of the Brooklyn Institute of Arts and Sciences and the American Museum of Natural History.

Dr. Rollin D. Salisbury, head of the department of geography and dean of the Ogden Graduate School of Science in the University of Chicago, went into camp about October 1 at Lake Nahuel Huapi, Patagonia, in the eastern Andes in latitude 41°. On his return he expects to stop at Rio de Janeiro and go back into the interior from that point to the great iron deposits of Brazil. Professor Salisbury will resume his work at the University of Chicago at the opening of the winter quarter, 1913.

Dr. W. J. G. Land, assistant professor in the department of botany at the University of Chicago, has sailed from San Francisco for a collecting trip in the islands of the southern Pacific. His course includes the Hawaiian, Tonga and Fiji Islands, and Australia. The object of the trip is primarily to observe and collect liverworts, and incidentally to collect interesting forms of other plant groups.

At the meeting of the Minnesota Pathologic Society at the university on October 15, the annual address was delivered by Dr. Ludvig Hektoen on "Recent Observation of Streptococci and the Streptococcal Infection."

"Problems of the Modern City" is the subject of a series of lectures being given by present and former professors of the University of Chicago in Fullerton Hall, of the Art Institute, Chicago, from October 15 to December 17. The course was opened by J. Paul Goode, associate professor of geography, who spoke on "The Dynamics of the City: Its Geography and Transportation." Robert Franklin Hoxie, associate professor in the department of political economy, followed with a lecture October 27 on "The Development of Industry and the Social Problems of a City." "The Health of the City" was the subject of a lecture by Edward Oakes Jordan, professor of bacteriology, on October 29.

Last year there was a decrease in the production of tungsten ore owing to the decrease in the demand for tool steels, in which the bulk of the tungsten produced is used, according to Frank L. Hess, in a report on this metal just issued by the United States Geological Survey. The production of domestic tungsten ore in 1911 amounted to 1,139 short tons of concentrates, carrying 60 per cent. of tungsten trioxide, valued at $407,985; in 1910 the production amounted to 1,821 short tons, valued at $832,992. Tungsten is used chiefly in making steels that will hold their temper when heated, but it is most generally known as supplying the filament of tungsten incandescent lamps. The great improvements in drawing tungsten wire and further notable improvements in the size of the globe of the tungsten lamp and in other mechanical details that add greatly to its efficiency are making it encroach upon the carbon-filament lamp and the arc lamp, and it is rapidly driving from the market the tantalum lamp, which was the first good incandescent lamp having a metallic filament. Diamonds are used for dies in drawing tungsten wire. At first it did not seem possible to drill small enough holes through the diamonds to make wire sufficiently fine for lamps of small candlepower, but wire 0.0006 inch in diameter can now be drawn in quantity. The total quantity of tungsten ore used for electric lights, however, amounts to only a few tons a year. New uses of tungsten, in making electric furnaces, electric contacts and targets for Röntgen rays, have been developed, and the last two products are being actively manufactured.

UNIVERSITY AND EDUCATIONAL NEWS

Mr. J. Pierpont Morgan has given $200,000 to Trinity College for the erection of a library and administration building.

Mr. James B. Brady, of New York City, has given $200,000 for the establishment of the Urological Institute at the Johns Hopkins Hospital. He has also undertaken to provide an endowment for the institute.

The sum of $60,000 has been given by an anonymous New York citizen toward the $800,000 which Smith College is undertaking to obtain in order to receive $200,000 from the General Education Board.

The new library building of the Ohio State University, built at a cost of $250,000, is nearing completion. While an additional appropriation will be needed to complete the equipment, the greater part of the library, which consists now of more than 115,000 volumes, will be moved into the new building within a few weeks.

Work on the stone foundation of the new University of Illinois armory is well under way. The interior dimensions of the armory will be 200 by 350 feet. The building under construction is not the complete building, but merely the drill room.

St. Louis University is building an addition to the Medical School, which will accommodate the offices and library and new laboratories for animal experimentation. It will cost about $10,000.

The dean of Johns Hopkins Medical School announces that it has become necessary to limit the number of students owing to the limited space and facilities in the various laboratories. The present enrollment is 355, the largest in the history of the school, and fifty other students were refused admittance prior to the beginning of the session.

The enrollment of students in the Ohio State University this year is 3,243, of whom 780 are in the College of Engineering.

Several members of the faculty of Western Reserve University will receive in certain special classes, during the semester October, 1912, to February, 1913, men and women who are teachers of the high schools and other schools of Cleveland and vicinity, and others interested in such courses.

Thomas Wingate Todd, M.B., Ch.B., F.R.C.S., at present lecturer in anatomy at Victoria University, Manchester, England, has been appointed Henry Willson Payne professor of anatomy in the medical department of Western Reserve University. Professor Todd will take up his duties at Cleveland about December 10.

Dr. Charles Lincoln Edwards has been appointed professor of embryology and histology in the medical department of the University of Southern California, and has been made director of the department of nature-study in the Los Angeles public schools.

The Ohio State University, Columbus, has the following new members in the faculty of the College of Engineering: Forrest K. Pence, professor of ceramic engineering; A. E. Flowers, professor of electrical engineering, and R. A. Brown, instructor in electrical engineering. The following members have been promoted to the rank of professor: Homer F. Staley, ceramic engineering; James R. Withrow, chemistry; Robert F. Earhart, physics; Frederic C. Blake, physics; Samuel J. Barnett, physics, and Edwin F. Coddington, mechanics.

The following changes have been made in the faculty of the New York State Normal College at Albany: Dr. Leonard A. Blue, formerly professor of education at Goucher College, has been appointed dean and professor of education in place of Dr. William B. Aspinwall, who resigned to become principal of the State Normal School at Worcester, Mass.; Dr. George S. Painter has been appointed professor of philosophy and psychology to succeed Professor Alfred J. Rejall, now assistant in psychology at Columbia University; Professor Herbert M. Douglass, formerly of Cornell University, has been appointed instructor in mathematics and mechanical drawing.

The following recent appointments in St. Louis University School of Medicine have been made: John Zahorsky, M.D. (Missouri Medical College), professor of children's diseases; Paul M. Carrington, M.D. (College of Physicians and Surgeons, Baltimore), of the Marine Hospital Service, professor of hygiene; Joseph Grindon, M.D. (St. Louis Medical College), professor of dermatology; George Ives, M.D. (Johns Hopkins University), assistant professor of bacteriology; A. M. Brown (Washington University), instructor in biology.

The School of Botany of the University of Texas announces the following changes and promotions: Dr. F. D. Heald, professor of botany, resigned to become pathologist to the Chestnut Tree Blight Commission of Pennsylvania; Dr. I. M. Lewis, promoted from instructor to adjunct professor; Dr. Frederick McAllister, instructor in botany, Cornell University, appointed instructor; Mr. Charles H. Winkler appointed by the board of regents to act as chairman of the school faculty for the term of two years.

DISCUSSION AND CORRESPONDENCE

AN ELECTROMOTIVE FORCE DUE TO MECHANICAL ACCELERATION

To the Editor of Science: From well-known mechanical principles it follows that when a solid body is given an accelerated motion each particle of the body is acted upon by a force having a direction opposite to that of the acceleration. In magnitude this force is equal to the product of the acceleration and the mass of the particle.

Applying this to the modern conception of "free electrons" in metals, it is clear that when a piece of metal is given an accelerated motion each electron within it should experience a force tending to move it and this force will be equivalent to an electromotive force. The magnitude of the latter is easily calculated.

The equivalent electromotive force in volts per cm. is

$$V=\frac{300a}{\left(\frac{e}{m}\right)},$$

where $V=$ volts per cm.

$e=$ charge of an electron in electrostatic units.

$m=$ mass of electron.

$a=$ the acceleration given to the metal.

That this equivalent electromotive force is not too small to be detected with appropriate apparatus can readily be shown. If a coil of wire is caused to oscillate rapidly about its own axis, for instance, the electromotive force of each turn is added to that of the next and thus the effect can be enormously magnified over what it would be in the case of one turn. An alternating electromotive force should be generated which when commutated would be within the range of a good galvanometer.

Whether the result of such an experiment were positive or negative it would be of great interest for modern theory, for in case it were positive it would give *directly* the *value* of e/m for the electrons within a metal, and if it were negative it would clearly indicate the falsity of some part of the modern theory.

The apparatus for such an experiment has been for some time in process of construction and I hope before long to report on the results.

D. E. Comstock

Massachusetts Institute of Technology,
September 25, 1912

REVERSION OF AMBLYSTOMA

To the Editor of Science: The following note on the reversion of adult *Amblystoma,* to the larval axolotl stage, may be of interest to students of amphibia.

A number of years ago, when the writer was a boy residing at Colorado Springs, he confined some "water-dogs" (*Amblystoma*), for a period of four or six weeks, in an artificial pool of water of small diameter. The pool was so fenced that the animals were unable to escape, though they repeatedly endeavored to do so. This enforced residence in the water seemed to effect in them a distinct transformation; the color became duller, the tail broader, the head assumed a more triangular form, and back of the head on each side of the neck, there appeared small, bluish knobs. These increased in size and became soft, slender, conical protuberances of bluish color, and about five eighths of an inch in length. These became the framework of a growth of a moss-like gill structure, that covered them completely. When these changes were complete, the "water-dog" had assumed the form familiar to the writer, and known to be the axolotl. This animal he had regarded as distinct from the "water-dog," and the apparent identity of the two animals impressed him greatly. Later he secured a publication concerning this, to him, amazing transformation; but the transformation therein described was of the reverse order, or from the axolotl form to that of the "water-dog." As the writer shortly after removed to the east, he had no opportunity of repeating the experiment, and finally dismissed the matter from his mind. If the facts here detailed have not been hitherto recorded, it would be interesting if some one would repeat this experiment, which is a too distant memory to be submitted as a scientific demonstration.

R. D. O. Johnson

NOTE ON THE LIFE HISTORIES OF THE FERN RUSTS OF THE GENUS UREDINOPSIS

Under *Peridermium balsameum* Peck the writer[1] described experiments and observations which indicated that the fern rusts belonging to the genus *Uredinopsis* are heterœcious, having their æcial stage on *Abies balsamea* (L.) Mill. Artificial infection experiments carried on during the present season by the writer have established the conclusions there stated. These experiments have shown that *Uredinopsis Osmundæ* Magn., *U. Struthiopteridis* Störmer, *U. Phegopteridis* Arthur, *U. mirabilis* (Peck) Arthur, and *U. Atkinsonii* Magn. have their æcial stages on *Abies balsamea* (L.) Mill. The æcia are the white spored forms that have passed as *Peridermium balsameum* Peck. A detailed description of the experiments will be published soon.

W. P. Fraser

Macdonald College,
Quebec

[1] *Mycol.*, 4: 189, 1912.

"PAWLOW"

I note with interest Professor Halsted's protest[1] against the spelling of Lobachevski's name with a "w," a sort of scientific Wellerism which Teutonic influence has foisted upon the English language. Is it too much to hope that some day we may find American physiologists referring to Pavloff instead of to Pawlow, or is it true that in such mixed crosses, as the heredity experts would say, German pedantry is prepotent over common sense?

J. F. Abbott

[1] Science, May 10, 1912, p. 736.

SCIENTIFIC BOOKS

Non-Euclidean Geometry. A critical and historical study of its development. By Roberto Bonola. Translated by H. S. Carslaw. Chicago, The Open Court Publishing Co. 1912.

To Dr. Paul Carus the world is greatly indebted for making this book accessible in the universal language, English.

There are two ways of envisaging the coming of non-euclidean geometry; either as a gradual development or as a saltation. The first attitude is taken in my article, "The non-euclidean geometry inevitable";[1] the second in the introductions to my translations of Lobachevski and Bolyai, where I say Lobachevski was the first man ever to publish a non-euclidean geometry, though Bolyai's marvel of genius went perfect to the printer in the same year, 1829, the most extraordinary two dozen pages in the whole history of thought.

Bonola's book takes the developmental viewpoint, and the first 83 pages give a just and adequate account of the forerunners of non-euclidean geometry, with whom belong Schweikart, Gauss and Taurinus, though far greatest of whom was Saccheri.

The inadequacy of the book is in the 30 pages, out of 268, devoted to the real founders of non-euclidean geometry, John Bolyai and Lobachevski, whose very names Carslaw has

[1] Monist, 4, 483–493.

bungled. The name of the proud young Magyar, Bolyai János, Bonola correctly translates into Italian as Giovanni Bolyai, John Bolyai. Carslaw seems to think him an Austrian, and always calls him Johann (16 times or more). He might as well have called him Ivan. The young Hungarian had the racial hatred for Austrians. In garrison, 13 of them, cavalry officers, challenged him at once with the saber. He accepted, only stipulating that between each two duels he might play a piece on his violin. He was victor over all.

His father, Bolyai Farkas, could at need deal more tactfully with the common enemy. When an Austrian Schulrath was sent with hostile intent to inspect the protestant college at Maros-Vásárhely, a nest of Magyar rebels, old Bolyai Farkas received him with exceeding geniality, related with zest and fire the experiences of his student life in Germany, and took him to dinner. They ate, drank and talked like two German students. "The interests of the college required it, and they said 'Du' to one another." And that the Schulrath should see near him no rebel faces, Farkas bade his son sacrifice his beautiful beard. Bolyai won. The Austrian was kept away from the college.

Franz Schmidt told me in Budapest his father had seen Bolyai János in Temesvár in mere wantonness of the pride of life cut off with his beautiful Damascus blade an iron spike driven into his doorpost. And now Carslaw in English calls him Johann!

No better fares it with Lobachevski. Bonola gives his name in Italian as Nicola Ivanovic Lobacefski, in which the very same Russian letter B is twice transliterated v and then f. Carslaw makes the worse blunder of twice transliterating it v and then w. But another single Russian letter, equivalent to the Italian c, our ch as in church, Carslaw transliterates as four letters together, and so in translating the name, Carslaw gives it *seven* additional letters, and besides all that, a substitute letter w which wholly destroys the sound, since Carslaw's tschew can have in English only the sound made offensive by Fletcher.

The fault of the seriously unsatisfactory and misleading exposition of Lobachevski's transition work of 1826 is Bonola's. Bonola pretends to know all about the contents of this memoir, never printed and of which no manuscript has ever been found, while really oblivious to the never explained paradox of its very name: Exposition succincte des principes de la géométrie, avec une démonstration rigoureuse du théorème des parallèles. What a horribly unfortunate title for a man who three years later began to publish work which shows such "démonstration rigoureuse" eternally impossible! He never confesses what it was.

And again when he gradually became conscious of "the possibility of the existence of geometry in a wider sense than that in which Euclid first expounded it to us," that which young John Bolyai, with his magnificent nerve, in 1829 called "The Science Absolute of Space," Lobachevski in 1835 called "Imaginary Geometry." In 1855, going blind and dying, he gives it at last a more worthy name, Pangeometry, but dies without its having obtained the slightest public recognition and without having made a single disciple. Nothing could be more false than Carslaw's sentence, p. 86:

> Non-Euclidean Geometry, just as it was conceived by Schweikart in 1816, became in 1829–30 a recognized part of the general scientific inheritance.

In fact for more than a third of a century thereafter, it was as if it had never been born.

A voluminous work by the academician Buniakovski appeared in St. Petersburg in 1853 in which Lobachevski is not even mentioned, and in all his published works Gauss never even once mentioned the name of Lobachevski or of John Bolyai. Yet the two dozen pages of John Bolyai was something incalculably tremendous. Is then the silence of Gauss to be attributed to meanness or blindness? He said he "feared the outcry of the Bœotians," if he should speak. Max Simon says, 1901, Never believe that Gauss ever doubted the actual truth of the parallel assumption for our space.

Yet just now, 1912, this space of ours is being proved non-euclidean by the principle of relativity. Says Vladimir Varičak in a wonderful lecture, "Ueber die nichteuklidische Interpretation der Relativtheorie,"[2]

I postulated that the phenomena happened in a Lobachevski space, and reached by very simple geometric deduction the formulas of the relativity theory. Assuming noneuclidean terminology, the formulas of the relativity theory become not only essentially simplified, but capable of a geometric interpretation wholly analogous to the interpretation of the classic theory in the euclidean geometry. And this analogy often goes so far, that the very wording of the theorems of the classic theory may be left unchanged.

To see that this will prove our space Bolyaian, we have only to remember Poincaré's dictum:

These two propositions, the earth turns round, and, it is more convenient to suppose that the earth turns round, have one and the same meaning.[3]

The first man to so bring forth the non-euclidean geometry that it was not stillborn, but lived and grew, was the Frenchman Hoüel, by his translations of Lobachevski in 1866 and John Bolyai in 1867. Thirty years later, in my translator's preface, I said:

No part of Lobachevski's largest work, "New Elements," has ever before been published in any language but the original Russian.

I gave an account of it in 1893 at the Mathematical Congress of the World's Columbian Exposition, and promised then the publication of my translation.[4] This promise was delayed for a personal visit to Kazan, the home of Lobachevski, and Maros-Vásárhely, the home of Bolyai. Only through his little book "Geometrical Researches,"[5] have Lobachevski's ideas been heretofore accessible to the world in general.

But it is preeminently in his "New Elements" that the great Russian allows free expression to his profound philosophic insight, which on the one hand shatters forever Kant's doctrine of our absolute *a priori* knowledge of all fundamental spatial properties, while on the other hand emphasizing the essential relativity of space.

The realities which with the aid of the euclidean space form we understand under motion and position, may, with the coming of more accurate experience, refuse to fit in that form. Our mathematical reason may decide that they would be fitted better by a non-euclidean space form. Space is presupposed in all human notions of motion or position. We may drop out such specifications from our space form as render it specifically euclidean. Euclidean space is a creation of that part of mind which has worked and works yet unconsciously.

It is not the shape of the straight lines which makes the angle-sum of a rectilineal triangle two right angles.

With straight lines of precisely such shape but in a non-euclidean space, this sum may be greater or less. In non-euclidean spaces, if one edge of a flat ruler is a straight line the other edge is a curve, if the ruler be everywhere equally broad. In any sense in which it can be properly said that we live in space, it is probable that we really live in such a space.

And now fifteen years later comes the relativity theory to prove all this, and to make non-euclidean geometry a powerful machine for advance in physics.

George Bruce Halsted

Greeley, Colo.

[2] *Jahresber. D. Math. Ver.*, 21, 103–127.

[3] "The Value of Science," Halsted's translation, p. 140.

[4] See "Mathematical Papers of Chicago Congress," pp. 92–95.

[5] Hoüel, 1866; Halsted, 1891.

Allen's Commercial Organic Analysis. Volume V. Tannins, Dyes and Coloring Matters, Inks. Edited by W. A. Davis and Samuel S. Sadtler. P. Blakiston's Son and Co. Philadelphia, 1911. Price $5.00.

This volume contains the following chapters: Tannins by W. P. Dreaper. Analysis of Leather by W. P. Dreaper. Dyes and Coloring Matters by W. P. Dreaper and E. Feilmann. Dyestuffs of Groups 6 to 12 by J. T. Hewitt. Coloring Matters of Natural Origin by W. M. Gardner. Analysis of Coloring Materials by W. P. Dreaper and E. Feilmann.

Coloring Matters in Foods by Albert F. Seeker. Inks by Percy H. Walker. Index.

Volume VI. Organic Bases, Vegetable Alkaloids. Philadelphia, 1912. Price $5.00. This includes Amines and Ammonia Bases by W. A. Davis. Aniline and its Allies by S. S. Sadtler. Naphthylamines, Pyridine, Quinoline and Acridine Bases by W. H. Glover. Vegetable Alkaloids by Thomas A. Henry. Volatile Bases of Vegetable Origin by Frank O. Taylor. Nicotine and Tobacco by R. W. Tonkin. Aconite Alkaloids by Francis H. Carr. Cocaine by Samuel P. Sadtler. Opium Alkaloids by Frank O. Taylor. Strychnos Alkaloids by Charles E. Vanderkleed. Cinchona Alkaloids by Oliver Chick. Berberine and its Associates by Edward Horton. Caffeine, Tea and Coffee by J. J. Fox and P. J. Sageman. Cocoa and Chocolate by R. Whymper.

The extensive scope of the work and the pains taken to secure the assistance of experts in the various fields is well indicated by the list of chapters given.

W. A. Noyes

The Flight of Birds. By F. W. Headley, M.B.O.U., with sixteen plates and many text figures. Witherby and Co., 326 High Holborn, London. 1912. 12mo. Pp. xii + 163. Price 5 shillings.

In this little book Mr. Headley has endeavored to describe briefly and clearly the flight of birds, keeping in view the methods and difficulties of those who are striving to rival them. In ten chapters he deals with methods, modes and apparatus of flight, an eleventh chapter being devoted to some accessories, circulation, breathing, etc., that are connected with, or modified by flight.

The first chapter deals with gliding, the resistance of the air, the curve of the wings and the area of supporting surface, matters which lie at the base of all flight. We then pass to stability, including voluntary adjustment, the latter a point wherein the feathered biped has the great advantage over his featherless rival of many thousands of years' experience. What man has to think about, the bird does instinctively. It is this instinct that enables a bird to fly successfully at the first trial of his wings, although he can not handle them so dexterously as he will later on and they may not carry him so far nor so fast as they will subsequently. And just here may we say that a bird does not fly stupidly into a telegraph wire; he simply does not see it until too late to evade it. The *Titanic* did not run stupidly into an iceberg; by the time it could be seen she was upon it. Also horizontal wires are not within the province of the bird's instincts, and in the grouse districts of Scotland, bits of wood are hung on telegraph and telephone lines to catch the bird's eye.

In connection with the relation of the shape of the wings to stability, it may be said that Mr. Huffaker, one of Professor Langley's assistants, reached the conclusion that the curved secondaries and more or less flattened primaries of the bird's wing were the great factors in stability and that the flattened wing tips also served as horizontal rudders, points wherein man has advantageously patterned after the bird.

Then come starting and steering, and the machinery of flight, muscles and bones. A little more space, perhaps, might have been devoted to the framework and to some of the rather perplexing problems it suggests—why is it that while sailing birds, the albatross and frigate bird, for example, have very small muscles their shoulder girdles are most rigidly constructed, the coracoid, clavicle and breastbone of the latter being immovably soldered together. In the great pterodactyl, *Pteranodon,* most marvelous of all flying creatures, we have in the massive collar bone special provision for bracing the wings. Perhaps in all these cases this strength is necessary, because the muscles themselves can not be relied upon to stand the strain. But in the almost flightless hoatzin we find the apparent anomaly of a rigid shoulder girdle. We think that, as is usually done, too much value is put upon the clavicle as a brace to the coracoids. Among the birds of prey it is of importance, but in the ducks and pheasants, birds of powerful flight, it is a negligible quantity; so it is in humming-birds and swifts, and some of the best flyers among parrots have an imperfect clavicle.

Chapter three deals with motive power, leverage, propulsion, wing stroke and the manner in which the wings attack the air, a manner well described on page 45.

Here, too, a query. Mr. Headley thinks that the kestrel can not hover unless the wind is blowing against him. We believe that the kingfisher *can* do this, and the humming-bird and hawk moth will hover above a flower and circle around it with no apparent difficulty. Mr. Headley points out that quality of muscle is quite as important as quantity, and notes that while ordinarily the elevator muscles are inferior to the depressor, in the guillemot, a swimming bird, they are on a parity. Undoubtedly his explanation is correct; the bird that uses its wings to fly beneath the water needs powerful muscles to raise them. This is in line with the deeply keeled sternum and abundant muscles of the penguin and great auk, birds incapable of aerial flight, that wing their way swiftly beneath the water.

Further chapters deal with the relation between the form of wings and mode of flight, speed and endurance and the influence of the wind. Here we find repeated the theory that soaring (circling upward) is made possible by upward currents of wind, a theory that we think few will find satisfactory. A bird may circle about in such a current, but it would not have strength enough to raise him and we feel that the most that can be said is that in some way, as yet beyond our power of imitation, birds, so to speak, screw themselves through the air to vast heights, over the level pampas as well as over the gusty mountain tops.

But one can not indulge in much discussion in little more than 150 pages and the average reader will prefer to have the facts rather than theories: and Mr. Headley has done well to give us so many facts and so much well-told information in so small a compass.

A feature of the book are the illustrations of birds, mainly pigeons, and for the most part from Mr. Headley's photographs, in various phases of flight. These give an idea of the varied poses of the wings and tail, and their relation to the balance of the bird, or direction of its flight, that can not be gained from words.

F. A. L.

SPECIAL ARTICLES

THE EVENING PRIMROSES OF DIXIE LANDING, ALABAMA

Bartram's locality for *Œnothera grandiflora* at Dixie Landing on the Alabama River some distance above Fort Mimms (1778) was rediscovered by Professor S. M. Tracy in 1904 and visited a second time by him in 1907. Seeds procured by Tracy have been widely distributed and have given rise to races of *Œnothera grandiflora* which are being studied by several investigators.

Œnothera grandiflora is one of the nearest allies of *Œ. Lamarckiana* and seems to agree with that species in at least some points pertaining to mutability and behavior on hybridizing. Its study may at some time lead to an explanation of those phenomena which until a short time ago seemed peculiar to *Œ. Lamarckiana*. Consequently it seemed to us to be of primary importance to study *Œ. grandiflora* in its original habitat, and we visited Dixie Landing under the kind guidance of Professor Tracy, on September 26 and 27.

It had been known from cultures grown by Professor B. M. Davis from Professor Tracy's wild seed that *Œ. grandiflora* did not occur at Dixie Landing as a single pure strain. It was no surprise, therefore, to find growing in the old cotton fields several forms of *Œ. grandiflora*, together with several forms of its companion species *Œ. Tracyi*, which has recently been described by one of us. The plants were partly in flower and partly in the rosette condition. Neither *Œ. grandiflora* nor *Œ. Tracyi* has heretofore been known as other than annual, and the abundance of rosettes which would obviously not flower this season was therefore a point of great interest. Seeds were obtained from all strains which had ripe capsules, and in addition a large collection of rosettes was sent to Washington to be grown there.

The evening primroses are found all along the river bluffs, often at the very edge of the perpendicular bank, which is some twenty feet higher than the river. In the old cotton fields they evidently find a favorable habitat, as may be concluded from their abundance in even very recently cultivated fields. The two species, *Œnothera grandiflora* and *Œ. Tracyi* were found growing together in all the fields which we studied, including those from which Professor Tracy's seed had been obtained in former years. Really pure stands of *Œ. grandiflora* we failed to find either in the old fields or in the woods along the river. Intermingled with the most frequent types of *Œ. grandiflora* and *Œ. Tracyi* were numerous less abundant types. This was particularly true in the old fields. It is hardly probable that all of the types which occur at Dixie Landing were observed by us. The following types, designated by letters from *a* to *l*, were noted, and of some of them seeds were obtained. Of other types, which were just coming into flower, seeds could not be obtained, but it is hoped that these will be found in the collection of rosettes which was sent to Washington.

1. Types like *Œ. grandiflora, i. e.,* types having large flowers with the style longer than the stamens: (*a*) with green, glabrous calyx segments and short capsules; (*b*) with green, viscid-puberulent calyx segments and short capsules; (*c*) with red-spotted, glabrous calyx segments and short fruit; (*d*) with red, glabrous calyx segments and long capsules; (*e*) with red-spotted, viscid puberulent calyx segments and short capsules; (*f*) with red-spotted glabrous calyx segments and petals orange-colored on wilting (all the other types were light yellow on wilting); (*g*) with red-spotted, glabrous calyx segments and pinnatifid leaves (all the other types had the leaves merely dentate or subdentate).

2. Types like *Œ. Tracyi, i. e.,* with flowers medium sized and stamens reaching the stigmas: (*h*) with green calyx segments and green, pilose capsules; (*i*) with green calyx segments and green, glabrous capsules; (*j*) with red-spotted calyx segments and green, pilose capsules; (*k*) with red-spotted calyx segments and pilose, longitudinally red-striped capsules; (*l*) with red calyx segments and green capsules, a beautiful form the coloration of which suggests that it may be a variant of *Œ. Tracyi* parallel to certain of the Amsterdam mutants of *Œ. Lamarckiana.*

The classification of the types of *Œ. grandiflora* does not take into consideration the pubescence of the stem, which varies widely, the shape of the leaves, which is equally variable, or the mode of branching, which can not be accurately judged in specimens growing under the diverse conditions afforded by the habitat at Dixie Landing. It should be noted that all of the *Œnothera grandiflora* types had glabrous, green capsules, that none of them were at all ambiguous with respect to the size and position of the floral parts, and that none of them could be considered at all similar to the *Œ. Lamarckiana* of the Amsterdam cultures. A very few specimens were found of which the broad leaves were somewhat crinkled, but so slightly so as to suggest that the variation was merely individual or accidental.

The classification of the types of *Œ. Tracyi* takes no account of the width of the leaves, or of the degree and kind of pubescence. Of course a more complete analysis of the composition of the *Œnothera* population at Dixie Landing will be made when the rosettes have flowered in Washington and a second generation has been grown from self-pollinated seed of all the forms found in the collection. At the present time it is sufficient to point out that no *Œnothera* from Dixie Landing, however constant it may seem to be when grown generation after generation from self-pollinated seed, can be cleared of the suspicion that it may be of hybrid origin. In other words, the same suspicion that attaches to so many of the strains of *Œnothera Lamarckiana* in Europe attaches to any strain of *Œnothera grandiflora* which is now being used by experimenters.

It is therefore of some importance to compare the conditions under which *Œ. grandi-*

flora grows at Dixie Landing with the conditions under which *Œ. Lamarckiana* occurs at its European stations. The race of *Œ. Lamarckiana* which occurs at Hilversum is unmixed, since no other species of *Œnothera* grows at that locality. Of its mutants only *Œ. læviflora* and *Œ. brevistylis* have been observed to flower regularly in the field: the other forms either do not flower at all or only so rarely as to have hardly any influence on the purity of the strain. In the sand dunes of Holland, on the contrary, *Œ. Lamarckiana* is mixed, as a rule, with European *Œ. biennis* and is observed to produce the three different hybrids which are obtained when these two species are artificially hybridized. The same statement holds good for many localities where the two species grow in France and England. Every individual from such a station, however closely its external characters may seem to coincide with those of one of the parent species, must always lie open to the suspicion of having had a hybrid ancestry.

In connection with the fact that the Dixie Landing types are so sharply divisible into two groups, it is permissible to suggest that they may correspond in a general way with hybrids between *Œ. Lamarckiana* and *Œ. biennis* "Chicago" which have already been studied. From the cross *Œ. Lamarckiana* × *Œ. biennis* "Chicago" and its reciprocal, two pairs of twin hybrids were obtained at Amsterdam in the first generation, viz., *Œ. læta* and *Œ. velutina*, and *Œ. densa* and *Œ. laxa*. The first pair of twins, from the cross *Œ. Lamarckiana* × *Œ. biennis* "Chicago," has already been described, the other pair, from the reciprocal cross, will soon be published in another paper. Possibly one group of the Dixie Landing types is related to *Œ. grandiflora* in the same way that *Œ. densa* and *Œ. læta* are related to *Œ. Lamarckiana*, and the other group to *Œ. Tracyi* as *Œ. laxa* and *Œ. velutina* are related to *Œ. biennis* "Chicago." Of course the situation at Dixie Landing is probably complicated by the recrossing of the hybrids with themselves and with their parents. However that may prove to be, the Dixie Landing types are now available for study and it is hoped that future work may show in what manner they are related. At the present time no conclusion regarding them is justified other than that they constitute so mixed a population that it is quite impossible to distinguish original parent types, if any such exist there, from the derivative types associated with them. In case the two most common types represent the original strains, the presence in other types of characters which are not common to either hypothetical parent suggests that *Œ. grandiflora* and *Œ. Tracyi* may prove to be additions to the list of species, including *Œ. Lamarckiana*, *Œ. cruciata* "Adirondack," European *Œ. biennis*, and *Œ. biennis* "Chicago," which are known to be in a mutable condition.

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THE GREAT CRESTED GREBE AND THE IDEA OF SECONDARY SEXUAL CHARACTERS

Certain facts in the structure and habits of this bird (*Podiceps cristatus* L.) have such a general bearing upon the whole conception of secondary sexual characters that it seems desirable to publish them here. The facts are these: the great crested grebe possesses an erectile ruff at the sides of the neck and a pair of erectile tufts on the head. The male is slightly larger in total size, and his ruff and tufts are also slightly larger, relatively as well as absolutely; otherwise the sexes are identical. The ruff and tufts are used extensively in courtship; at other times they are only occasionally erected, and then never to their full extent. The courtship-actions, including all the movements of ruff and tufts, are identical in the two sexes. The ruff and tufts and the actions in which they are concerned would be called secondary sexual characters, were they not common to both sexes, for secondary sexual characters are always defined with regard to this very point, their difference in the two sexes. I take a random definition, chosen for its brevity. Dewar and Finn[1] say that they are "those characters which differ with the sex, but are not directly connected with the act of reproduction." Darwin[2] defines them very similarly, but then adds:[3]

> There are, however, many animals in which the sexes resemble each other, both being furnished with the same ornaments, which analogy would lead us to attribute to the agency of sexual selection. . . . It is probable that the ornaments common to both sexes were acquired by one sex, generally the male, and then transmitted to the offspring of both sexes.[4]

As far as I can understand, however, he is talking merely of structures, not of those combinations of a structure with the instinct for displaying that structure which constitute the real secondary sexual *characters.*

The grebe is, so far as I know, unique in this—that structures which are only used in courtship (*i. e.,* which must *in origin* be due to sexual and not to natural selection) are now not only the common property of both sexes, *but are actually used in display, and used in exactly the same way by both sexes.*

The question of nomenclature remains; what are we to call characters like these, that have arisen through sexual selection, but exist equally in both sexes? The term "secondary sexual," as we have seen, will not do. A word does exist, however, which is perfectly applicable, and that is the word *epigamic.*[5] It would indeed be more satisfactory if we were always to use the term *epigamic* of all characters that owed their origin to sexual selection, whether they are found in one or both sexes, and keep the term *secondary sexual* in the wider sense that it often has now, to include *all characters peculiar to one sex except the primary sexual characters* (of gametes and gonads) *and the accessory sexual characters* (of genital ducts, copulatory apparatus, etc.). This would cover such epigamic characters (the great majority) that are confined to one sex, as well as many other characters, such as the mammæ of female mammals or the wingless condition of various female moths, which are not epigamic, nor accessory in the strict sense of directly helping the union of the gametes, but have been evolved through natural selection to perform some special function of their own.

J. S. Huxley

Balliol College, Oxford,
July, 1912

[1] "The Making of Species," 1909, p. 298.

[2] "Descent of Man," 1871, p. 253.

[3] *Ibid.,* p. 277.

[4] There is no necessity to multiply quotations; I will merely refer the reader to some apposite passages, *e. g.,* Poulton, "Essays on Evolution," 1908, pp. 379, 380; Archdall Reid, "Laws of Heredity," 1910, p. 145; Weismann, in "Darwin and Modern Science," 1909, pp. 43, 48; in "The Evolution Theory," 1904, Vol. I., pp. 232, 233.

[5] Poulton, *loc. cit.*

VOLCANIC ACTION IN THE BLACK HILLS OF SOUTH DAKOTA[1]

In recent work on geology of the northern Black Hills I have found a sheet of obsidian and associated agglomerates which doubtless are the products of surface extrusion. The locality is 1¼ miles northwest of Roubaix or 6 miles south by east of Deadwood in the midst of a large area of pre-Cambrian schists. The many large masses of igneous rocks in this region are well known from descriptions by Newton, Crosby, Jaggar and others, but so far as recorded they are of intrusive nature and of early Tertiary age. The White River deposits (Oligocene) in and about the Black Hills contain large amounts of fragments of these igneous rocks, the products of erosion, and also much volcanic ash of contemporaneous origin. The source of this ejected material has always been a problem, and while the effusive rocks near Roubaix can not be precisely correlated with White River deposits they appear to indicate that there was volcanic action in this region in mid-Tertiary time.

The obsidian is a sheet about 15 feet thick and of small extent. Its smooth lower surface lies on a one-foot layer of impure volcanic ash which is underlain by a thick mass of agglomerate or flow breccia of apparent rhyolite

[1] Published by permission of the Director of the U. S. Geological Survey.

fragments. This breccia is in masses surrounded by a deposit of finer-grained agglomerate which is nearly a square mile in extent. Other smaller masses of similar agglomerates were found five miles southeast of Roubaix. These occurrences are remnants of larger masses, for they have been subject to extensive erosion. The original vents are not preserved but their stocks are now represented by some of the dikes which occur at many places in the schists or overlying Paleozoic rocks.

These facts suggest that the Black Hills may have been the source of part if not all of the large amount of the volcanic ash which occurs intermixed and interbedded in the deposits of Oligocene age as well as in later formations in various parts of South Dakota and Nebraska.

N. H. Darton

U. S. Geological Survey

INTERNATIONAL CONGRESS OF PREHISTORIC ANTHROPOLOGY AND ARCHEOLOGY

The fourteenth International Congress of Prehistoric Anthropology and Archeology was held in the aula of the university, Geneva, September 9–14, 1912. On the evening of the 8th, Professor Eugene Pittard, president of the congress, and Professor Edouard Naville, honorary president, received the members informally at the Atheneum. The attendance was good throughout the week, 149 delegates being present from 112 institutions representing at least 20 nations, 12 of which sent government delegates. A. Hrdlička, George Grant MacCurdy and Charles Peabody represented the United States government. The total enrollment was nearly 600.

It had been over six years since the last congress (Monaco) was held. In view of the immense progress made in the domain of the prehistoric during this time, the program was exceptionally long and interesting. As no provision had been made for a division of the program into sections each treating a related group of subjects, it was necessary not only to limit each speaker to ten minutes, but also to abridge the discussion far beyond a desirable limit. Fortunately, however, many of the papers were supplemented by generous exhibits of original specimens, casts, drawings, plans, photographs, etc., for which the university furnished suitable cases and ample wall space conveniently located. The large collection of original specimens from Spain including remains of *Elephas antiquus* associated with a Chellean and perhaps pre-Chellean industry, and the Celti-iberian sepultures, exhibited by the Marquis of Cerralbo deserve special mention. Other exhibitors, to all of whom the thanks of the members present are due will be indicated in the program that is to follow.

The following amendments to the constitution recommended at the Congress of Monaco, were adopted at the first seance of the Geneva Congress and went immediately into effect:

> The official language of the congress is French; it is used for the publication of the proceedings and the correspondence of the commission of organization and of the committee. However, the members of the congress may, in their letters, communications or readings, make use of German, English or Italian. Communications in these three languages shall be accompanied by a résumé in French, and the discussions before the congress shall continue to be made in French.
>
> The maximum number of communications which any author may enter on the program is limited to four.

At the same seance an anthropometric commission consisting of the following members was appointed to continue the work of unification of anthropometric measurements begun at the Congress of Monaco[1] and to report at the close of the session:

MM. Chantre (France), Czekanowski (Russia), Duckworth (Great Britain), Frassetto (Italy), Giuffrida-Ruggeri (Italy), Godin (France), Hillebrand (Hungary), Hoyos Sainz (Spain), Hrdlička (United States), Loth (Russian Poland), von Luschan (Germany), MacCurdy (United States), Manouv-

[1] Compte Rendu, Congr. intern. d'anthr. et d'archéol. préhs., 13[e] session, Monaco, 1906, tome II., pp. 377–394.

rier (France), Marett (Great Britain), Mayet (France), Mochi (Italy), Musgrove (Great Britain), Pittard (Switzerland), Rivet (France), Schlaginhaufen (Switzerland), Sergi (Italy), Sollas (Great Britain), Volkov (Russia), Weisgerber (France).

This commission held four meetings, on the 11th from 8 o'clock till noon under the presidency of Manouvrier; on the 13th from 8 o'clock till 11 and from 3 till 4 under the presidency of Sergi; on the 14th from 9 till 10 under the presidency of Duckworth.

The reporters appointed were Duckworth, Rivet and Schlaginhaufen.

The entire report was adopted unanimously by the commission in the meeting of the 14th, and by the congress on the same day in its closing session.

INTERNATIONAL AGREEMENT FOR THE UNIFICATION OF ANTHROPOMETRIC MEASURES ON THE LIVING

General Principles

(*a*) For measurements on living subjects, the upright position is adopted.

(*b*) The projection method is adopted, except in cases where special mention is made of a different method.

(*c*) For paired measurements, it is recommended to operate on the left side and to take bilateral measurements for the height of the acromion and the great trochanter above the surface on which the subject stands.

(*d*) Observers are urged always to indicate precisely their method and instrumentation.

(*e*) It is very particularly recommended to persons desirous of using anthropometry not to be content with a theoretical study of the measuring processes, but to learn them practically in the different laboratories where they are taught.

Measures in Detail[2]

1. *Height.*—Subject standing on a horizontal firm surface (not leaning against a vertical wall or support), the arms pendent, the palm of the hand turned inward, the fingers vertical, the heels touching, the eyes directed horizontally. In this position measure the height of the vertex above the horizontal surface on which the subject stands.

[2] Translated from Dr. Rivet's copy. Measures marked by an asterisk are those for which the subject should be in the same position as for the height (measure No. 1).

*2. *Auditory Opening.*—Starting point: the deepest portion of the notch between the tragus and the helix (point already adopted at the Monaco Congress, op. cit., p. 391).

*3. *Chin.*—Starting point: median point on the inferior border of the mandible.

*4. *Presternal Notch.*—At its lowest point.

*5. *Nipple.*—Start from its center. Exclude women with pendent breasts.

*6. *Umbilicus.*—Center of the umbilical cicatrice.

*7. *Pubis.*—Median point on the superior border of the pubis. In cases where it is difficult to locate this point, be guided by the lower ventral fold.

*8. *Spinous Process of the Fifth Lumbar Vertebra.*—To find this point easily, cause the trunk of the subject to be flexed, a position in which the spinous process in question is indicated by a prominence.

9. *Height Sitting.*—Cause the subject to be seated on a stool, horizontal and firm, 30 to 40 cm. in height (this height varying with the height of the subject), the legs flexed. Place the back in contact with a vertical plane or with the anthropometer at the level of the sacral region and between the two shoulder blades. The head should be in the same position as for the height standing. Measure the height of the vertex above the horizontal plane of the stool.

10. *Height of the Pelvis.*—The subject being in the position for the height sitting, measure the height of the summit of the iliac crest above the plane of the stool.

*11. *Acromion.*—Upper external border of the acromion.

*12. *Great Trochanter.*—Upper border of the great trochanter.

*13. *Anterior Superior Iliac Spine.*—Summit of this spine. In cases where it is difficult to find this point, follow Poupart's ligament to its point of insertion, which is precisely the spine in question.

*14. *Elbow.*—Radio-humeral line.

*15. *Wrist.*—Inferior point of the styloid process of the radius.

*16. *Extremity of the Middle Finger.*

*17. *Knee.*—Point on the upper margin of the internal tuberosity of the head of the tibia.

*18. *Ankle.*—Inferior point of the internal malleolus.

*19. *Stretch.*—Place the subject against a wall, the arms extended horizontally, the hands completely open, the palm forward, and measure the distance from the extremity of one middle finger to that of the other. If no wall is to be had, place the rigid anthropometer horizontally behind the subject, whose position should be the same as above described, and take the same measure. Whichever method is employed, demand of the subject the maximum extension.

*20. *Biacromial Diameter.*—Maximum distance between the two acromions.

*21. *Bihumeral Diameter.*—Maximum distance between the two deltoid prominences (measure of secondary importance).

*22. *Bimamelon.*—Distance between the centers of the two nipples (same observation as for measure No. 5) (secondary measure).

*23. *Biiliac Diameter.*—Maximum distance between the external margins of the iliac crests.

*24. *Bispinal Diameter.*—Distance between the two anterior superior iliac spines (cf. measure No. 13).

*25. *Bitrochanteric Diameter.*—Maximum distance between the external faces of the great trochanters. It is necessary to press firmly against the tissue.

*26. *External Antero-posterior Diameter of the Pelvis.*—Starting points: in front, upper border of the pubis and in a median line; behind, summit of the spinous process of the fifth lumbar vertebra.

*27. *Transverse Diameter of the Thorax No. 1.*—Measured in a horizontal plane at the level of the xiphoid appendix. Take the average of the measures noted during inhalation and exhalation, or take the measure in an intermediate state.[3]

*28. *Transverse Diameter of the Thorax No. 2.*—In a horizontal plane at the level of the upper border of the fourth chondro-sternal articulation (secondary measure).

*29. *Antero-posterior Diameter of the Thorax No. 1.*—In the same plane as measure No. 27.

*30. *Antero-posterior Diameter of the Thorax No. 2.*—In the same plane as measure No. 28 (secondary measure).

*31. *Height of the Sternum.*—Measured with sliding compass from the lowest point of the presternal notch to the base of the xiphoid appendix.

32. *Bicondylar Diameter of the Humerus* (secondary measure).

33. *Bistyloid Diameter of the Forearm* (secondary measure).

[3] For measures Nos. 27–29 it is necessary to employ calipers with large blunt extremities, as the points of ordinary calipers would slip into the intercostal spaces, thus falsifying the results.

34. *Bicondylar Diameter of the Femur* (secondary measure).

35. *Bimalleolar Diameter* (secondary measure).

*36. *Thoracic Circumference.*—In a horizontal plane at the level of the base of the xiphoid appendix (secondary measure).

37. *Circumference of the Neck.*—The smallest circumference.

38. *Circumference of the Arm.*—The maximum circumference below the deltoid, the arm being in a state of repose.

39. *Circumference of the Arm in Contracted State.*—Maximum circumference at the same level as measure No. 38 (secondary measure).

40. *Maximum Circumference of the Forearm.*—At the level of the epitrochlear and epicondylar muscles.

41. *Minimum Circumference of the Forearm.*—Above the styloid processes of the radius and ulna.

42. *Maximum Circumference of the Thigh.*—At the level of the gluteal fold.

43. *Minimum Circumference of the Thigh.*—Just above the knee.

44. *Circumference of the Calf.*—The maximum.

45. *Minimum Circumference of the Ankle.*

46. *Minimum Circumference of the Waist.*

47. *Contour of the Hand.*—The right hand is applied on a leaf of paper, the fingers moderately separated, the axis of the middle finger in line with the axis of the forearm. Mark the two extremities of the bistyloid line, from these points trace the contour of the palm and fingers with a pencil cleft longitudinally and held perpendicular to the paper. Mark by points the termination of each interdigital space and the metacarpo-phalangial articulation at each side.

48. *Contour of the Foot.*—The right foot is placed on a leaf of paper, the leg being perpendicular to the paper. Mark by a stroke the extremities of the malleoli and the metatarso-phalangial articulation at each side; then trace the contour of the foot and toes in the same way as for measure No. 47, indicating the termination of each interdigital space. It is useless to trace the internal border between the malleolar and the metatarso-phalangial points, as it would always be inexact.

49. *Height of the Arch.*—The foot in the same position as for measure No. 48, measure by means of a vertical sliding compass the vertical distance from the plane of support to the upper border of the scaphoid (secondary measure).

The Anthropometric Commission as well as the congress unanimously adopted the following technique and resolutions:

RECONSTRUCTION OF THE HEIGHT BY THE AID OF THE LONG BONES

To reconstruct the height by the aid of the long bones, measure the maximum length of these bones, with the exception of the femur, which is to be measured in position, and of the tibia, which is likewise to be measured in position, without the spine.

Resolutions

1. *Resolved,* that for the graphic representation of skulls, anthropologists employ the horizontal plane either of Broca or of the Frankfort agreement.

2. *Resolved,* that anthropologists publish integrally all their measures.

It was voted to recommend to the next congress, which will no doubt be held at Madrid in 1915, an amendment to the constitution admitting Spanish on the same footing as English, German and Italian (a similar recommendation to admit all the Slavic languages was rejected); also that hereafter the program be divided into sections: (1) the stone age, (2) the age of metals and (3) anthropology properly so called (somatology), with the understanding, however, that communications comprehensive in character should still be treated in general session.

The following resolutions were adopted:

1. Asking Slavic societies and authors to give résumés of their publications in French, German or Latin.

2. That in view of the danger to originals from fire and theft, museums possessing important prehistoric or protohistoric objects made of precious metals be asked to have the same reproduced in metal or plaster.

3. That this congress enter into amical relations with an international congress[4] now in process of formation and destined to cultivate particularly the field of ethnography and physical anthropology.

The council in which this last resolution took shape were of the opinion that the name eventually to be chosen for the new congress should not be such as would lead to confusing it with that of the existing congress, and that the two should not meet in the same year. The fifteenth session of the International Congress of Prehistoric Anthropology and Archeology will be held in 1915, at Madrid in case of an official invitation. The new international congress, as yet unnamed, will probably take final shape at the Washington meeting of the International Congress of Americanists, and the first session perhaps called for 1916.

The one fact that stood out most impressively at Geneva was the recent development of the prehistoric in Spain, on the one hand by the Marquis of Cerralbo and on the other by the Institut de Paléontologie Humaine in Paris, an international institution founded by the Prince of Monaco. Within the last five years the Marquis of Cerralbo has in his private capacity excavated fifty-two prehistoric stations and is now carrying on work at ten. Through his efforts the government of Spain founded last June a Commission de Exploraciones Espeleologicas, a branch of the Instituto Nacional de Ciencias Naturales. This foundation was inspired in a large measure by the success of the Institut founded by the Prince of Monaco. It is fortunate that prehistoric archeology should have the powerful support of two such influential men, both of whom received a special vote of thanks of the congress. Another name that should not be overlooked in this connection is that of M. Louis Siret, a Belgian with large business interests in Spain, who for many years has made good use of his exceptional archeological opportunities. If the present rate of progress continues along these lines during the next three years, the Madrid congress will be a pilgrimage that no prehistorian can afford to miss.

The social functions of the week were especially well regulated and highly enjoyed by all present. Each member was given a "carnet" which contained not only the dates and places of the events, but also free coupon tickets to and from each function. On Monday from 5 to 8:30 P.M. Professor Edouard Naville (honorary president) and Mme. Naville received at their beautiful country place, Malagny, near Geneva. The whole of Tues-

[4] See Science, N. S., XXXV., 980, 1912.

day afternoon was devoted to an excursion to Salève, where President Pittard gave an interesting talk on "The Prehistoric of the Environs of Geneva." Thursday afternoon the city council of Geneva received at the Ariana Museum; and in the evening Professor Oscar Montelius, of Stockholm, gave an illustrated lecture on "The Relations between Italy and Central Europe during the Bronze Age." A tour of the Lake of Geneva (or Lake Léman as the inhabitants of the Canton of Vaud prefer to call it) occupied the whole of Thursday with luncheon in the historic Castle of Chillon offered by the state council of the Canton de Vaud, and dinner on board the boat offered by the local committee of the congress. The city waterfront was brilliantly illuminated for the return at 8 P.M. The city of Geneva was hostess Friday afternoon from 4 to 6 at the new Museum of Art and History (containing also important prehistoric collections). The same evening Professor Émile Cartailhac lectured before a large audience in Victoria Hall on "Man of the Caverns." The official banquet in the foyer of the theater Saturday evening offered by the state council of the Republic of Geneva and followed by a representation of a "Fête Montagnarde" closed the festivities of the week. It was made the occasion of the official announcement of the founding of an Institute of Anthropology at Geneva, that President Eugene Pittard was to be the director and that in addition to the professorship, ample funds had been raised by private subscription to meet the annual needs of such an institute. In preparation for, and especially during the week of the congress, Professor Pittard abundantly demonstrated his fitness for the new post to which he has been called; and Geneva did well to honor him in the presence of his colleagues assembled from all parts of the world.

About forty members accepted the invitation to take part in a five days' excursion (September 16–20) to important lake dwellings and museums—Bevaix (Treytel), Neuchâtel, St. Blaise, La Tène, Bienne, Bâle, Zürich, Lucerne, Lausanne.

The following is a complete list of the papers presented at the congress:

J. Bayer: "The Glacial Periods (theories of Penck)."

Abbé H. Breuil: "The Subdivisions of the Upper Paleolithic and their Significance."

J. Hillebrand: "The Paleolithic Cavern of Pesko, Hungary." (Exhibit of original specimens.)

L. Capitan: "The Evolution of the Stone Industry during the Paleolithic."

Marquis of Cerralbo: "Torralba, the Most Ancient Station of Europe in which Archeological Remains have been found." (Exhibit of original specimens.)

V. Commont: (1) "Chronology and Stratigraphy of Neolithic and Paleolithic Industries in the Holocene and Pleistocene Deposits of Northern France, especially in the Valley of the Somme." (2) "A Mousterian Industry Associated with a Warm Fauna in the Valley of the Somme." (Exhibit of original specimens.)

A. Mochi: "The Succession of Paleolithic Industries and Changes in the Pleistocene Fauna in Italy." (Exhibit of original specimens.)

M. Anton: "New Quaternary Crania from Spain." (Exhibit.)

L. Capitan and D. Peyrony: "The Recent Discovery of Two Mousterian Skeletons at La Ferrassie (Dordogne)."

L. de Hoyos Sainz: "Crania of the Cro-Magnon Type from Old Castille." (Exhibit of photographs and maps.)

R. R. Marett: "Prehistoric Man in Jersey."

M. Boule: (1) "*Homo neandertalensis* and the Place it should occupy among the Hominidæ." (Exhibit of casts.) (2) "The Institute of Human Paleontology in Paris."

Giuffrida-Ruggeri: "A Scheme of Classification for Living Hominidæ."

Count Bégouen: "A New Cavern with Parietal Engravings in the Department of Ariège: the Cavern of the Tuc d'Audoubert." (Exhibit.)

Abbé H. Breuil and L. Capitan: "Engravings on Stalagmite from the Cavern of Teyjat, Dordogne." (Exhibit of original drawings.)

I. Dharvent: "The First Step in the Prehistoric Art of Europe."

M. Hoernes: "The Prehistoric Art of Europe by Epochs and Regions."

B. Reber: (1) "The Age and Significance of the Prehistoric Engravings." (Exhibit.) (2)

"Certain Series of New Prehistoric Engravings." (3) "Prehistoric Fortification in the Neighborhood of Geneva."

S. Reinach: "Some Specimens of Cavern Art."

L. Coutil: "Tardenoisian, Capsian, Getalian, Geneyenian (geometric flints)." (Exhibit.)

L. Didon: "An Aurignacian Station near Sergeac."

G. Jousset de Bellesme: "Comparative Technique in the Amygdaloid Type of Industry."

The Abbés H. Obermaier and H. Breuil: "Excavations at the Cavern of Castillo (Spain)."

G. Lalanne: (1) "The Venus of Laussel." (Exhibit of casts.) (2) "Azilian Stations on the Shore of Bas Medoc."

E. Pittard: (1) "The Prehistoric in the Valley of Rebières." (2) "Aurignacian Station: Les Rebières II." (Exhibit of original specimens.)

E. Pittard and R. Montandon: "An Aurignacian Microlithic Industry." (Exhibit of original specimens.)

R. A. Smith: "An Aurignacian Facies in England." (Exhibit of original specimens.)

Th. Volkow: "Recent Discoveries in a Paleolithic Station at Mélène, Ukraine." (Exhibit of original specimens.)

M. Baudouin: "The Orientation of Dolmens."

Baron A. Blanc: "Excavations in Savoy: Preliminary Results, Azilian, Neolithic, Eneolithic and Protohistoric."

Marquis of Cerralbo: (1) "Iberian Necropoles." (Exhibit.) (2) "Neolithic Monuments of Central Spain."

H. Corot: (1) "Prehistoric and Protohistoric Times in Alesia." (2) "The Excavation of a Tumulus at Minot, with Incineration 'in domo.' "

Abbé F. Hermet: (1) "Statue Menhirs of Aveyron and of Italy." (2) "Bronze Spheroids." (3) "The Sepulcral Cavern of Nant."

R. A. Stewart-Macalister: (1) "Some Excavations recently made in Ireland." (2) "A Neolithic Cavern at Ghezer (Palestine)."

D. MacRitchie: (1) "Cyclopean Constructions in Scotland." (2) "The Kayak in Northeastern Europe." (3) "Pygmies among the Ancient Egyptians and the Hebrews."

J. de Saint-Venant: "Some Curious Iron 'Tranchets' of the La Tène Period."

Mme. Barnett: "Prehistoric Stone Amulets from Teotihuacan, Mexico."

A. Hrdlička: "The Remains in Siberia, Mongolia and other Parts of Eastern Asia of a Race that Peopled America."

Charles Peabody: "The Present State of the Question of Diluvial Man at Trenton, New Jersey."

N. H. Winchell: "Prehistoric Man in Kansas." Read by Dr. Peabody. (Exhibit of original specimens.)

L. Siret: "Comparative Study of the Symbols Represented on Protohistoric Monuments or Objects."

M. Baudouin: (1) "Comparative Study of Pediform Sculptures and Engravings." (2) "Comparative Study of Engravings Representing the Horse's Foot."

J. Déchelette: "Origin and Use of Iron in Europe."

M. Exsteens: "Industry of the Extinct Tasmanians."

H. Müller: (1) "Stations with Azilian Facies from the Neighborhood of Grenoble." (2) "The Necessity of an International Commission on Archeological Nomenclature."

Mme. Crova: "Neolithic Implements from the Coast of Mauritania, Africa." (Exhibit of original specimens.)

H. S. Wellcome: "Prehistoric Discoveries in the Soudan." (Exhibit.)

F. Huybrigts: "The Earliest Manifestations of Religious Ideas by Neolithic and Druidic Populations according to the Discoveries made at Tongres, Belgium." (Exhibit.)

L. Schaudel: "Pitted Stones, their Origin, Significance and Destination."

G. B. M. Flamand: (1) "Prehistoric Sahara." (2) "The Worship of the Sun in Prehistoric Times."

F. Sarasin: "Colored Pebbles from the Cavern of Birseck, near Bâle." (Exhibit of original specimens.)

G. Nicole: "Prehistoric Vases from Thessaly."

H. Hubert: "The Androphagous Carnivor of the Gundestrup Vase." Read by S. Reinach.

G. Reubel: "An International Organization for the Anthropometry of Children."

P. Godin: "The Relation between the Evolution of Growth and Puberty."

S. Reinach: "An Iberian Ornament." (Exhibit.)

H. M. Ami: "The Status of Archeological Work in Canada."

L. Bidault de Grésigny: "Prehistoric Researches in the Saône Valley."

C. Florence: "How to Recognize the Age of Ferruginous Scoria."

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THE AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE

MICROORGANISMS OF THE SOIL [1]

SUCH statements as "the soil is not a mere sponge, but is teeming with life" or that "the earth is one of nature's vast laboratories in which microscopical wonder-workers perform incredible experiments" may have been unusual enough at one time to attract attention; but no longer is the presence or performances of these inhabitants of the soil of such novelty as to startle or dismay us. Indeed so accustomed have we become to the idea that each gram of the upper layers of the earth is filled with its millions or billions of bacteria, that the tendency is to ascribe all functions of the soil to its micro-flora and no theory is too bizarre, no miracle too improbable, so long as we may fall back upon the soil bacteria to account for it.

The apologetic statement only a short while ago of a German investigator, that perhaps, after all, the chemical condition of the soil might have almost as much to do with a given condition as the bacteria, illustrates, if nothing else, the great changes that have taken place in our conception of the constitution of the earth's surface during the last twenty years. To attempt to indicate the relative places of the various aspects of science which are concerned in problems of the soil would be as useless as it is impossible, but I might as well say at once that I do not feel that the situation calls for any particular glorification of the biologist. I do not wish to

[1] Presented at the Symposium on Soils at the Washington meeting of the American Association for the Advancement of Science.

be misunderstood as minimizing the importance of a real knowledge of the activities of the micro-flora and fauna of the earth. Rather would I hope to emphasize this aspect of the question, which I suppose is what was expected when the subject was assigned to me. It is quite as important, however, to point out the unsatisfactory state of the investigations at present and the futility of generalizing from a few known facts, acquired by disregarding a vast number of unknown, but nevertheless real, factors.

Fischer, you will remember, after a more or less critical review of the situation, came to the conclusion that we do not now possess a method of bacteriological examination of soils, which is of the least practical value. While not subscribing to this view, it must be confessed that a study of the literature on the subject indicates that much of fundamental importance remains to be done before we can hope that an investigation of the microorganisms of the soil will result in really solving some of the perplexing problems of fertility now confronting us. Even the nomenclature of the subject is so indefinite at the present time, that within the past year we have had conflicting uses of such familiar terms as "nitrification" and "nitrogen fixing" and there certainly is need for some such unification and strict definition of terms as that suggested by Lipman.

An enumeration of all the methods now in vogue for the bacteriological examination of the soil would show that the technical side of the subject is in much the same condition that water bacteriology was fifteen years ago, and until there is more uniformity in methods employed, by which comparative tests can be made, we shall not gain much from the results of the steadily increasing number of workers in this field. It is true that new points of view are occasionally presented and a distinct step in advance has been the emphasis recently placed upon the study of the organism, as far as possible, in its natural environments, rather than in artificial solutions. The work of Vogel, Stevens and others, has done something to make possible an agreement in parallel laboratory and field experiments; but, after all, progress in this line has been chiefly through pointing out the errors of others and has not resulted, as yet, in the formulation of a standard. We are much farther along in knowing what not to do, but like the Sherman law, the situation calls for some affirmative legislation.

There is also considerable evidence that we have been so obsessed by the pure culture idea, that conclusions drawn from experiments performed under such conditions are entirely unwarranted. If it is true that mixed cultures of *Azotobacter chroococcum* and *Pseudomonas radicicola* will fix almost twice as much nitrogen as either alone, to say nothing of the necessary interaction between various groups in making available green manures, phosphoric acid, lime nitrogen, etc., it is very evident that conclusions drawn from the study of a single organism can not be applied to the conditions actually existing in the soil. We might as well assume that a superior being, dipping down into our atmosphere and selecting a single individual, would be able to arrive at the various functions and activities of man on the face of the globe, by observing his behavior under such artificial conditions as it would be possible to maintain in a heavenly laboratory. It is neither necessary, nor advisable, of course, that we abandon the pure culture method. But we should recognize the limitations of our present technique and cease to generalize from such inadequate data.

Not only are standardization of methods and interpretation of results, as well as a still further recognition of the effect of various groups of bacteria, one upon the other, much to be desired; but an appreciation of the fact that something else than the bacteria go to make up the microscopical life of the soil, must be more generally taken into consideration, in our attempts to find out what actually goes on in the ground. It must be confessed that thus far any knowledge of the algal, fungal or protozoal inhabitants of the soil has tended to confuse rather than clarify any conclusions regarding the phenomena induced by a single group of organisms.

Perhaps no better example of the chaotic conditions of the present status of the microbiology of the soil can be cited than in the recent revival of a consideration of the effect of heat and various so-called antiseptics on crop production, and the supposed relations of protozoa to the problem. That the addition to soil of carbon bisulphide, toluol, ether and similar agents, will *under certain conditions* benefit *some* crops, has of course been known for nearly twenty years, and as early as 1888 Frank believed that sterilizing soil with steam increased the solubility, or availability, of mineral and organic substances.

Various theories, from the mere removal of superabundant, though harmless, bacteria, to the destruction of toxins, have been proposed to account for this beneficial effect, but it remained for Russell and Hutchinson, of the Rothamsted Station, to stimulate interest in the subject. These investigators, in October, 1909, announced that they had found the increased productiveness of partially sterilized soil to be due to an excess of ammonia, arising as a result of the bacterial decomposition of soil substances, these bacteria being able to multiply enormously on account of the removal, by heat or volatile substances, of large protozoa which normally feed upon the bacteria. This announcement was hailed both in this country and abroad as the greatest discovery pertaining to the soil, since Hellriegel's interpretation of the beneficial effect of bacteria in the root-nodules of legumes!

A student in my laboratory becoming interested in the problem, undertook a considerable number of preliminary experiments, the results of which seemed to warrant a more elaborate investigation into the effect of soil sterilization upon crop production. It is not necessary to go into details at this time, but laboratory, greenhouse and field tests all indicated most decidedly that the theory of Russell and Hutchinson is *not* of universal application, and the importance of the protozoa, so far as their effect upon bacteria is concerned, has been overestimated. It is true that Russell and Hutchinson themselves considered the removal of the protozoa as being but one factor concerned in the benefits accruing to plants, by the use of antiseptics, and it may be that the prominence given to this aspect of their work is due to the advertising propensities of those not immediately concerned with the investigations. This is unfortunately sometimes the case. The fact remains, however, that in many of the comments published by those rather closely associated with Russell and Hutchinson, the effect of antiseptics upon protozoa is deemed to be the only one worth considering, and to which all resulting benefit is due.

Within the last few months, several papers have appeared which likewise fail to agree with Russell's and Hutchinson's results. Goodey, publishing in the *Proceedings of the Royal Society,* shows that at least one important group of protozoa, microphotographs of which have been used most extensively to illustrate popular articles on the subjects, can have no part whatever in disposing of beneficial bacteria or influencing in any appreciable way the fertility of the soil. For it is found that the ciliated protozoa which are so characteristic a feature of cultures made from soil, exist only in the encysted stage in natural soil conditions. There remain, of course, the amœbæ and flagellates, about the condition of which in soil we are not certain as yet. But the fact that all of these organisms are able, within a short time after being removed by disinfectants, to reestablish themselves in soils, would seem to indicate that even though they might have some direct effect upon the bacterial content of the soil, the removal is so transient that the effect on crop production is negligible. This is no place for figures, but if it were I could show as the result of tests, extending over a wide field, that the number of protozoa, including flagellates, ciliates and rhizopods, existing in the soil three days after treatment with various percents of toluol, carbon bisulphide, etc., may equal or even exceed the number originally present.

Koch and Fred at the Agricultural Institute of the University of Göttingen, since the appearance of Goodey's paper, have each published independently upon the effect of ether and carbon bisulphide on lower and higher plants and conclude that for both the micro-flora of the soil and the crop it bears, the beneficial effect is purely stimulative—simply the old idea of all poisons being beneficial to growth if sufficiently dilute.

Greig-Smith, in spite of the apparent refutation of the toxin theory of Russell and Hutchinson, returns to it as affording the best explanation of the observed results. He claims to have extracted from soil a substance which is filterable through porcelain and which is toxic to bacteria. This toxin thus retards the growth of higher plants by the destruction of beneficial bacteria, but in turn is destroyed by the application of heat or volatile antiseptics. An additional effect of these agents is upon the so-called "agricere," which, according to Greig-Smith, is a mixture of saponifiable and unsaponifiable bodies, coating or waterproofing particles of soil. When heat or certain wax solvents are added to the soil, they alter the distribution of the earth wax, carrying it to the surface and causing it to segregate on the points of the soil particles. The beneficial effect of the removal of the waterproof covering is of course that the constituents of the soil are more easily attacked by the bacteria and rendered available for plant nutrition.

Bottomly, before the British Association this summer, confirmed to a certain extent the work of Greig-Smith by demonstrating the injurious effect of the "bacteriotoxines" upon the germination of seeds and their subsequent growth, the harmfulness of which could be prevented by first heating the soil.

Without further reference to contradictory results obtained by various investigators since the announcement of Russell and Hutchinson, experiments in my own laboratory indicate that the matter is probably incapable of being satisfactorily explained by any of the single factors which have been suggested. The one fact which does seem to be fairly well established is that the temporary removal from the soil of the protozoa has but little bearing on the problem. Neither is it by any means certain that the use of heat or antiseptics is universally favorable to all crops on all kinds of soil and it seems probable that the character of the soil, as well as the kind of crop, will have to be taken into consideration before we can have a true explanation of why some crops are benefited by the so-called sterilization of some soils.

Aside from a very few pathogenic forms, but little is specifically known of the fungus flora of the earth. That fungi may be as abundant as the bacteria, particularly in uncultivated soils and that below the humus-containing layer, they may considerably exceed the bacteria, has been ascertained by a few analyses. But what they do and how they do it, is for the most part a matter of conjecture. To those familiar with the rapidity and certainty with which some of the higher fungi reduce organic to inorganic matter, it is evident that there is no group of organisms present in the soil that would seem to be more capable of producing profound changes in its environment. Not only do we know that a considerable amount of the decay in animal and vegetable tissue, particularly the early stages, is due to the higher fungi, but the work of Czapek and Kohn, showing that *Penicillium* and *Aspergillus* when supplied with ammonium chloride set free hydrochloric acid, as well as the demonstration of the production of an organic acid in *Penicillium* by Alsberg and Black, points to still further possibilities by plants belonging to the same, or closely related groups.

Formerly it was supposed that the number of plants whose roots entered into combination with some fungus—presumably for mutual benefit—was limited and confined to but few families. Now it is estimated that about one half of the seed plants possess within their roots some mycorhizal organism and in many notable instances the plant is unable to thrive under natural conditions without its particular fungus. Furthermore, as has been pointed out by Coville, the acidity factor in the distribution of some plants is mycological rather than purely chemical.

Our knowledge of the effect of soil fungi upon the germination of seed is also being extended. Barnard has recently shown that seed of both the common potato and *Solanum dulcamara* fail to germinate in the absence of their mycorhizal parasite, while 40–90 per cent. begin to grow in the presence of this fungus.

Whether the considerable number of wild yeast-like organisms occurring abundantly in many soils, are capable of producing profound changes in their habitat is still problematical. That certain of these may fix atmospheric nitrogen in the laboratory seems to have been demonstrated, and it appears reasonable that should conditions in the earth be favorable, we might expect yeasts to have a decided effect either upon the soil, or its inhabitants. Despite the necessity of yeasts having secondary breeding places, such as aqueous extracts from fruits and other vegetable matter, the soil must be considered the chief abode of these fungi, and not only during the colder months, but throughout the entire year.

Even less is known about the algal content of the soil than of its fungus constituents. The older literature is full of references to the nitrogen-fixing power of both grass-greens and blue-greens, but it is a striking fact that since the introduction of the pure culture method for algæ, there has been no authenticated demonstration of the power of these plants to add in the slightest degree to our store of fixed nitrogen. It is true that Heinze working with impure cultures of *Nostoc* thought he had demonstrated by a process of elimination its ability to fix nitrogen. Since *Azotobacter* was not present and the fungus in the culture could not by itself fix nitrogen, he assumed that the nitrogen accumulated must be due to the alga. But this can hardly be accepted as conclusive. While it it possible that some of the blue-greens may have this power, it is not likely that they are of much importance and there is need of a most careful investigation of the whole subject, now fortunately under way, before we can be at all certain of what the algæ alone accomplish in the soil.

The possible beneficial relationship between the algæ and the bacteria is quite another question. I believe it is not widely known that quite independent of any surface growth of algæ, there exists in the lower layers of the soil an algal flora which in some localities, at least, is equal, bulk for bulk, to the bacterial flora. Exact quantitative estimates are difficult and in the incomplete state of the work, only approximations can be made, but it is safe to say that under some circumstances the individual algal cells, many times larger, of course, than ordinary bacteria, number between three and four million per gram of soil. For the most part these cells belong either to *Anabæna* or *Nostoc,* and without committing myself at this time to the original observations of Brand, recently confirmed by Miss Spratt, that the heterocyst of *Nostoc* and *Anabæna* gives rise to gonidia-like spores, I may say that heterocysts obtained from the deeper layers of the soil often show the contents divided in precisely the way figured by Brand and Miss Spratt. If it be true that the heterocyst is capable of giving rise to spores, it would account, of course, for the large number of isolated cells found in the soil, and further explain how there may be such an abundant algal flora below the surface, which, be it noted, is totally different, as to genera, from the surface film of algæ.

The observations relative to the fixation of atmospheric nitrogen through the association of algæ and bacteria are somewhat more satisfactory than those dealing with algæ alone. We have some experimental evidence for believing that when certain nitrogen-fixing bacteria are growing with some of the blue-green algæ, the amount of nitrogen exceeds considerably that fixed by the bacteria alone and the benefit of the combination upon growing crops is marked. Thus we have an additional complication in dealing with the vital activities of the soil, for it appears we must not only consider the interrelationships between various groups of bacteria in so-called "mixed culture," but the influence of a considerable algal flora must also be taken into account.

No discussion of the microorganisms of the soil would be complete without some reference to the nodule-forming bacteria of legumes. That the practical application of our knowledge of the effect of these, usually, but not always, beneficial bacteria must be demonstrated in the field, rather than the laboratory, goes without saying. However, it is hard to understand how we may hope to gain much definite information either as to the needs or activities of these bacteria, when conclusions regarding them are drawn exclusively from such an inconstant and uncertain source. That much depends upon the virulence of the particular strain of organism is evident and the use of nitrogen-free media, first suggested in this country and some modification of which has since been widely adopted, both at home and abroad, has resulted in increasing materially the percentage of successful inoculations. Whether the conflicting results obtained by different investigators can be harmonized, in the state of our present knowledge, is doubtful, for the conditions are bound to be so various and the bacteria themselves so sensitive to changed environment, that comparable results will seldom be obtained. Indeed, it may not be impossible that *Pseudomonas radicicola* plays a more important rôle outside of the root nodules than within it, and instead of attempting to induce the legume organism to form nodules on other crops, we should perhaps be paying more attention to the organism as it exists in the soil, independent of the roots of any plant.[2]

In this connection, however, I may say that I now have under cultivation an organism capable of fixing nitrogen within nodules comparable in every way to those found on the legumes, but growing on a family far removed from the Leguminosæ, namely, the Aristolociaceæ.

Of the importance of the bacterial flora in rendering available, to higher plants, the various necessary mineral constituents of the soil, little need be said. That a large number of organisms are able to influence the potash, lime, magnesia, phosphorus and other minerals of the soil solution is well known. It even appears that calcium salts of various organic acids, frequently formed by plants and occurring in soils, may be oxidized to carbonates by a considerable variety of bacteria, thus conserving the lime supply to the last degree. On the other hand, it may be well to point out that the generally accepted theory regarding the action of the so-called iron-bacteria is probably incorrect. Winogradsky's hypothesis, that the soluble bicarbonate in water or soil was absorbed by the organism and, as a result of cell metabolism, changed into ferric hydroxide, was never proved, even by its author. The analogy between the appearance of iron on the walls of these forms and the oxidation processes of the sulphur and nitrate bacteria seems to have been the chief reason for its promulgation. Molisch has shown that iron is not necessary for the growth of these organisms and later other investigators proved that manganese readily replaced the iron. There seems to be no reason, therefore, for assuming that the deposition is in any way connected directly with the metabolism of the plant. Rather is the relationship similar to that existing in certain algæ and an aquatic ascomycete, recently obtained by me. Klebs showed that *Zygnema* could retain in the gelatinous layer surrounding it, not only iron, but aluminium and chromium compounds. Whether this is due to some peculiarity in the wall, or is a sort of reversed chemotaxis, with the plant attracting the metal, instead of the chemical attracting the plant, remains to be seen. Observations made on the fungus above referred to plainly indicate that it is not necessary to ascribe any respiratory or oxidizing function to the process, and if it be vital it must be something in the nature of what we might be permitted to call "vegetable magnetism."

Without going further into details, I think enough has been said to indicate the diverse character, and yet the close inter-relationship, existing in the microbiological content of the soil. While it may not appear to simplify the problem, by admitting that the physiologist, the bacteriologist, the mycologist, the algologist and possibly the protozoologist, to say nothing of the chemist and physicist, must all coöperate before many fundamental problems

[2] Since writing the above, I have learned that Greig-Smith recently presented a paper before the Linnean Society of New South Wales in which he claims, by means of a special medium, to have determined the number of *Pseudomonas radicicola* per gram of cultivated soil, to be at least three millions. He, apparently from the literature on the subject, and not by actual test, assumes that the number of *Azotobacter* and similar nitrogen-fixing organisms is small and consequently concludes that the foremost place in nitrogen fixation in the soil should be given to *Pseudomonas* and not *Azotobacter*. Indeed he goes so far as to maintain that the number of *Pseudomonas* organisms in the soil affords an indication of its comparative fertility.

involving fertility and plant nutrition are finally solved, I am inclined to think this is the only means whereby we can hope for success. At least the information derived in this way is more apt to bring us to the desired state of knowledge than our present independent attitude. "The sciences gain by mutual support," wrote Pasteur. Certainly it is not by an arrogant assumption to one's self that his particular science is the "be all and end all" of human endeavor, that we shall gain any notion of what is really happening in the soil and what it all means!

George T. Moore
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PLANT FOOD IN RELATION TO SOIL FERTILITY[1]

I take it that the only justification for me to review the subject of plant food in relation to soil fertility or crop production is the fact that recent publications from the federal Bureau of Soils have strongly affirmed that there is no necessity of applying plant food in the restoration and maintenance of soil fertility. Two principal questions are raised: First, Does plant food applied increase crop yields in harmony with recognized soil deficiencies and crop requirements? Second, Will the rotation of crops maintain the productive power of the soil by avoiding injury from possible toxic excreta from plant roots? I shall try to present facts and data and exact quotations rather than my own opinions concerning these questions of such fundamental importance in relation to systems of permanent agriculture.

In 1804 DeSaussure, the French scientist, first gave to the world a correct and almost complete statement concerning the sources of the food of plants, including not only the confirmation of Sénébier's discovery of the fixation of carbon in the formation of carbohydrates, but also the evidence of plant requirements for the essential mineral elements secured from the soil.

Sir Humphry Davy and Baron von Liebig did much to popularize this information during the following half century; and they were followed by Lawes and Gilbert, whose extensive and long-continued investigations furnished the needed proof that the soil must furnish nitrogen as well as the mineral elements; and finally, only twenty-five years ago, Hellriegel discovered the symbiotic relationship between legumes and bacteria which gives access to the inexhaustible supply of atmospheric nitrogen for soil enrichment.

Briefly, it might be said that for nearly a century the world of science has accepted and taught, and the world of advanced agricultural methods has practised, the doctrine that soil fertility maintenance and soil enrichment require the restoration or addition of plant food, including particularly phosphorus and nitrogen, which are most likely to become deficient in normal soils, potassium where needed, and sometimes lime or limestone, which always supplies calcium, and magnesium as well if dolomitic limestone be used. Of the other five essential elements, carbon and oxygen are secured from the carbon dioxid of the air, hydrogen from water, and iron from the inexhaustible supply in the soil; while the sulfur brought to the soil in rain and otherwise from the atmospheric supply, resulting from combustion and decomposition of sulfur-bearing materials, supplemented by the soil's supply and by that returned in crop residues, appears to be sufficient to meet the plant requirements and the loss by leaching.

After nearly a century of the increasing

[1] Presented at the Symposium on Soils at the Washington meeting of the American Association for the Advancement of Science.

agricultural practise of this doctrine on much of the farm land of Germany, France, Belgium, Holland, Denmark and the British Isles, those countries have approximately doubled their average acre-yields. The ten-year average yield of wheat in the United States is 14 bushels per acre, while that in Europe has gone up to 29 bushels in Germany, to 33 bushels in Great Britain, and to more than 40 bushels per acre in Denmark. The annual application of phosphorus even to the soils of Italy has already become greater than the phosphorus content of all the crops removed. The exportation of our highest grade phosphate rock from the United States to Europe now exceeds a million tons a year, carrying away from our own country twice as much phosphorus as is required for the annual wheat crops of all the states, and millions of acres of farm land in our own eastern states have already been agriculturally abandoned, because of depleted fertility and reduced productive power; so that it is now impossible for our congressmen to enter the capital of the United States from any direction without passing abandoned farms.

Ultimate analysis has shown that the most common loam soil of southern Maryland,[2] almost adjoining the District of Columbia, contains only 160 pounds of phosphorus, 1,000 pounds of calcium and about 900 pounds of nitrogen in two million pounds of surface soil, corresponding approximately to an acre of land 6⅔ inches deep. The clover crops harvested from the rich garden soil at Rothamsted in eight consecutive years removed more phosphorus and calcium from the soil than the total amounts contained in the plowed soil of this worn-out Maryland land, whose total nitrogen content is also less than would be required for seven such crops of corn as we harvest on good land in the central west, which, however, contains ten times as much of these plant foods as the depleted Maryland soil.

[2] See "Leonardtown Loam," Bureau of Soils Bulletin 54, and "Field Operations of the Bureau of Soils" in Reports for 1900 and 1901; or see pages 138 to 142 of "Soil Fertility and Permanent Agriculture," Ginn & Company, Boston.

During the last ten years our population increased 21 per cent., the same as during the preceding decade, while the acreage of farm lands increased only 5 per cent., and the federal government reports all future possible increase in farm land at only 9 per cent. of our present acreage.

Average crop yields for four ten-year periods are now reported by the United States Department of Agriculture. A comparison of two twenty-year averages shows increased acre-yields of 1 bushel for wheat and ½ bushel for rye, while the yield of corn has decreased 1½ bushels and the yield of potatoes has decreased 7 bushels per acre, by twenty-year averages. These crops represent our greatest sources of human food, even our supply of meat being largely dependent upon the corn crop. Less than twenty-year averages are not trustworthy for a consideration of any small increase or decrease in yield per acre. It should be noted that during the last forty years vast areas of virgin wheat land have been put under cultivation, including the Dakotas, which now produce more wheat than all the states east of the Mississippi, save only Indiana and Illinois.

A comparison of the last five years with the average of the five years ending with 1900 shows that our wheat exports decreased during the decade from 198 million to 116 million bushels, and that our corn exports decreased from 193 million to 57 million bushels.

Thus we have fed our increasing population not by increasing our acre-yields, but by a slight increase in the acreage of farm land, and by a large decrease in our exportation of food stuffs; and the fact must be plain that before another decade shall have passed we shall reach the practical limit of our relief in both of these directions.

Indeed, a most common subject already discussed in the press and investigated by national, state and city authorities during the last three or four years is the high cost of plain living.

With these facts and statistics before us, let us consider the actual results secured from field and laboratory investigations:

Where wheat has been grown every year since 1844 on Broadbalk Field at Rothamsted, England, the average yield for fifty-five years has been 12.9 bushels per acre on unfertilized land, 35.5 bushels where heavy annual applications of farm manure have been made, and 37.1 bushels per acre where slightly less plant food has been applied in commercial form.

Barley grown every year on Hoos Field at Rothamsted has produced, for the same fifty-five years, an average yield of 14.8 bushels on unfertilized land, 47.7 bushels with farm manure and 43.9 bushels where much less plant food was applied in commercial form.

Potatoes grown for twenty-six consecutive years, also on Hoos Field at Rothamsted, produced, as an average, 51 bushels per acre on unfertilized land, 178 bushels where farm manure was used (reinforced with acid phosphate during the first seven years), and 203 bushels where plant food was applied in commercial form. The first year of this investigation the unfertilized land produced 144 bushels, land receiving farm manure alone produced 159 bushels and land fertilized with commercial plant food produced 328 bushels per acre.

Director A. D. Hall, of the Rothamsted Experiment Station, makes the following statement on pages 95 and 96 of his book on "The Rothamsted Experiments":

> On the plots receiving farmyard manure, and even on those receiving only a complete artificial manure, the crop was maintained in favorable seasons. No falling-off was observed which could be attributed to the land having become "sick" through the continuous growth of the same crop, or through the accumulation of disease in the soil.

In commenting upon these same experiments, Milton Whitney, Chief of the United States Bureau of Soils, makes the following statement in Farmers' Bulletin No. 257, page 14:

> One of the most interesting instances going to show that toxic substances are formed and that what is poisonous to one crop is not necessarily poisonous or injurious to another is a series of experiments of Lawes and Gilbert—the growing of potatoes for about fifteen years on the same field. At the end of this period they got the soil into a condition in which it would not grow potatoes at all. The soil was exhausted, and under the older ideas it was necessarily deficient in some plant food. It seems strange that, under our old ideas of soil fertility, if the soil became exhausted for potatoes, it should grow any other crop, because the usual analysis shows the same constituents present in all of our plants, not in the same proportion, but all are present and all necessary, so far as we know. This field was planted in barley, and on this experimental plot that had ceased to grow potatoes they got 75 bushels of barley.

If, now, we turn to the actual records of the Rothamsted experiments we find that the first crop of barley grown after twenty-six years of potatoes was 33.2 bushels per acre on unfertilized land, only 24.8 bushels where minerals alone had been used and the soil depleted of nitrogen by the potato crops, 67 bushels per acre where minerals and nitrogen had been used, and 72.4 bushels where farm manure had been applied for twenty-six years. We also find in strict harmony with Director Hall's statement, that the largest average yield of potatoes from the farm manure plots (3 and 4), either for one year or for five years, was secured after potatoes had been grown on the same land for more than fifteen years.

On permanent meadow land at Rothamsted, the average yield of hay for fifty years was 1¼ tons per acre on unfertilized land, and more than 4 tons per acre on land heavily fertilized with commercial plant food. During the last ten years of this fifty-year period the unfertilized land has produced an average yield of 1,863 pounds of hay, while the fertilized land has produced 8,490 pounds per acre.

On Barn Field at Rothamsted, mangels were grown for thirty years. The average yield per acre was 4¼ tons on unfertilized land, 19½ tons where farm manure had been applied, and 29 tons per acre where the farm manure had been reinforced with nitrogen and phosphorus in commercial form.

In 1902 the University of Illinois began a series of experiments on the common corn-belt prairie land in McLean County, on a field which had grown no wheat for thirty-two years. We first grew wheat in 1905. Four plots not receiving phosphorus produced, respectively, 28.8 bushels, 30.5 bushels, 33.2 bushels and 29.5 bushels of wheat per acre; while four other plots which differed from these only by the addition of phosphorus, at the rate of 25 pounds of that element in 200 pounds of steamed bone meal per acre per annum, produced 39.2 bushels, 50.9 bushels, 37.8 bushels and 51.9 bushels, respectively, per acre. Six years later wheat was again grown on this land, when the four plots not receiving phosphorus produced, respectively, 22.5 bushels, 25.6 bushels, 21.7 bushels and 27.3 bushels per acre, and the other four plots, which differ from these in treatment only by the phosphorus applied during the ten years, produced 57.6 bushels, 60.2 bushels, 54.0 bushels and 60.4 bushels, respectively, of wheat per acre, this being the second crop of wheat grown on this land in forty years.

This most common prairie land of the Illinois corn belt contains 600 pounds of phosphorus and 18,000 pounds of potassium per million of surface soil, while one million pounds of the subsoil contains 450 pounds of phosphorus and 27,000 pounds of potassium. This is the type of soil on which, as an average of four different tests each year under four different conditions of soil treatment, the addition of phosphorus produced an increase in yield per acre of 9.6 bushels of corn in 1902, of 17.8 bushels of corn in 1903, of 14.8 bushels of oats in 1904, of 14.4 bushels of wheat in 1905, of 1.46 tons of clover[3] in 1906, of 18.8 bushels of corn in 1907, of 17.3 bushels of corn in 1908, of 15.2 bushels of oats in 1909, of 2.56 tons of clover[3] in 1910 and an average increase of 33.8 bushels of wheat per acre in 1911.

As an average of four similar tests during the ten years, applications of potassium (costing the same as the phosphorus) increased the yield of corn by 3.1 bushels, decreased the yield of oats by 2.3 bushels, decreased the yield of clover by 70 pounds per acre and increased the yield of wheat by 0.1 bushel per acre, these being the general average results from four years of corn and from two years each of oats, clover and wheat.

If now we turn to the extensive peaty swamp soil of northern and north-central Illinois, we find by analysis that it contains in one million pounds of the surface soil 1,960 pounds of phosphorus and 2,930 pounds of potassium, or more than three times as much phosphorus and less than one sixth as much potassium as the com-

[3] Average of two tests (see Illinois Soil Report No. 2, pp. 17, 39).

mon prairie. We also find that, as an average of triplicate tests each year, potassium increased the yield of corn per acre by 20.7 bushels in 1902, by 23.5 bushels in 1903, by 29.0 bushels in 1904 and by 36.8 bushels in 1905; while the addition of phosphorus produced a decrease of 0.1 bushel in 1902 and an increase of 0.9 bushel in 1903, of 3.9 bushels[4] in 1904 and of 0.3 bushel in 1905.

As an average of the results from twenty plots of unfertilized land in the Pennsylvania rotation experiments with corn, oats, wheat and hay (clover and timothy mixed), the crop values in two consecutive twelve-year periods decreased by 26 per cent.; while, as an average of the twenty-four years, the crop values were increased 62 per cent. by farm manure and 65 per cent. with commercial plant food, as compared with the results from unfertilized land.

The records from the Agdell rotation field at Rothamsted show that as an average of the turnips, barley, clover (or beans) and wheat the yield decreased on unfertilized land by 42 per cent. measured by the results from two consecutive thirty-two-year periods; and, if we span a sixty-year period, we find that the yield of turnips on unfertilized land was 10 tons per acre in 1848 and less than ½ ton in 1908; that the barley yielded 46.5 bushels in 1849 and only 10 bushels per acre in 1909; the clover produced 2.8 tons in 1850 and less than 1 ton per acre in 1910; while the wheat following clover produced 39.7 bushels in 1851 and 24.5 bushels in 1911.

The application of plant food (for the turnip crop only) in the same rotation over a period of sixty-four years increased the average yield of turnips from 1¼ tons to 17½ tons per acre, increased the yield of the barley following from 24.4 to 38.5 bushels, then increased the average yield of legumes from 1,945 pounds to 4,413, and increased the yield of wheat after legumes from 25 to 34.8 bushels, as compared with the unfertilized land.

If, again, we span the sixty years, we find that on the fertilized land the yield of turnips was 12½ tons in 1848 and 17½ tons in 1908; that barley produced 35.9 bushels in 1849 and 33.4 bushels in 1909; that clover produced 3½ tons in 1850 and 4½ tons in 1910; while wheat yielded 30.3 bushels in 1851 and 38 bushels per acre in 1911.

Thus, the records show that during the last four years, following a sixty-year period, the plant food applied has increased the yield of wheat by 55 per cent., increased the barley by 234 per cent. and the clover by 340 per cent.; while the yield of turnips on the fertilized land was 49 times as great as on the unfertilized land.

With these facts in mind we may well consider the following statements from Whitney in Farmers' Bulletin 257:

> Apparently, these small amounts of fertilizers we add to the soil have their effect upon these toxic substances and render the soil sweet and more healthful for growing plants. We believe it is through this means that our fertilizers act rather than through the supplying of food to the plant. (Page 20.)
>
> There is another way in which the fertility of the soil can be maintained, viz., by arranging a system of rotation and growing each year a crop that is not injured by the excreta of the preceding crop; then when the time comes around for the first crop to be planted again the soil has had ample time to dispose of the sewerage resulting from the growth of the plant two or three years before. . . . Barley will follow potatoes in the Rothamsted experiments after the potatoes have grown so long that the soil will not produce potatoes. The barley grows unaffected by the excreta of the potatoes, another crop follows the barley, and the soil is then in condition to grow potatoes again.

[4] Irregular insect injury in 1904 (see Illinois Bulletin 123, pp. 251, 252).

In other experiments of Lawes and Gilbert they have maintained for fifty years a yield of about 30 bushels of wheat continuously on the same soil where a complete fertilizer has been used. They have seen their yield go down where wheat followed wheat without fertilizer for fifty years in succession from 30 bushels to 12 bushels, which is what they are now getting annually from their unfertilized wheat plot. With a rotation of crops without fertilizers they have also maintained their yield for fifty years at 30 bushels, so that the effect of rotation has in such case been identical with that of fertilization. (Pages 21, 22.)

If we turn to the Rothamsted data, we find that the first recorded yield of wheat on the unfertilized plot on Broadbalk Field was not 30 bushels, but only 15 bushels; that the average of the first eight years was 17.4 bushels; that the best fertilized plot on the same field has averaged not 30 bushels, but 37.1 bushels for fifty-five years; that, as stated above, the wheat grown in rotation, following a leguminous crop, has averaged not 30 bushels, but 25 bushels on unfertilized land, and 34.8 bushels where fertilizers are applied for turnips three years before.

The following pertinent quotations are from Whitney and Cameron in Bureau of Soils Bulletin 22:

In England and Scotland it is customary to make an allowance to tenants giving up their farms for the unused fertilizers applied in previous seasons. The basis of this is usually taken at 30 to 50 per cent. for the first year, and at 10 to 20 per cent. for the second year after application; but, in the experience of this bureau there is no such apparent continuous effect of fertilizers on the chemical constitution of the soil. (Page 59.)

It appears further that practically all soils contain sufficient plant food for good crop yield; that this supply will be indefinitely maintained. (Page 64.)

In Bureau of Soils Bulletin 55, by Whitney, entitled "Soils of the United States," issued in 1909, we find under the heading "Permanency of Soil Fertility as a National Asset" the following summarized statements:

The soil is the one indestructible, immutable asset that the nation possesses. It is the one resource that can not be exhausted; that can not be used up. (Page 66.)

From the modern conception of the nature and purpose of the soil it is evident that it can not wear out, that so far as the mineral food is concerned it will continue automatically to supply adequate quantities of the mineral plant food for crops. (Page 79.)

As a national asset the soil is safe as a means of feeding mankind for untold ages to come. (Page 80.)

As stated in the beginning, I have not planned to discuss the subject of plant food in relation to soil fertility; but I felt it a duty as well as an honor to be permitted to accept a place on your program; and I have placed before you some most important and trustworthy data bearing upon the question. I have presented some statistics for consideration in connection with the gravest problem which now confronts America; namely, the problem of restoring American soil and of maintaining American prosperity. I have quoted accurately and fairly from the teachings of Whitney and Cameron; and I also submit for your information the following quotation from Director A. D. Hall, of Rothamsted:

I can not agree with Professor Whitney's reading of the results on the Agdell field in the least. The figures he quotes for wheat are hardly justifiable as approximations, and are in spirit contrary to the general tenor of the particular experiment. . . . In my opinion the results on the Agdell rotation field are directly contrary to Professor Whitney's idea that rotation can do the work of fertilizers. (From Report of the Committee of Seven, appointed by the Association of Official Agricultural Chemists "to consider in detail the questions raised," published in full in Circular 123 of the University of Illinois Agricultural Experiment Station.)

A thousand additional proofs of the practical value and of the evident necessity of supplying plant food in systems of permanent agriculture could easily be cited.

All long-continued investigations and, likewise, all practical agricultural experience show that great reduction in crop yields ultimately occurs unless plant food is restored to the soil; and, as a rule, the chemical composition of normal soil is an exceedingly valuable guide in determining the kinds of material which should be supplied in practical systems of soil enrichment and preservation.

Cyril G. Hopkins
University of Illinois

THE FIFTH INTERNATIONAL CONGRESS OF MATHEMATICIANS

Once every four years the mathematicians of the world meet together to discuss the new discoveries made in the various branches of their science, to review the work accomplished during the past quadrennial period, to listen to mathematical papers and to become acquainted with one another. The fifth International Congress of Mathematicians was held at Cambridge University, August 21 to 28, 1912, at the invitation of the Cambridge Philosophical Society. The four former congresses were Zurich, 1897; Paris, 1900; Heidelberg, 1904; Rome, 1908. During the World's Fair at Chicago in 1893, a similar international gathering of mathematicians was held, but this meeting is not usually included in the list of meetings of the International Congress.

The opening meeting was devoted to welcoming addresses by the president of the Cambridge Philosophical Society, Sir George Darwin, and the vice-chancellor of the university, Mr. R. F. Scott. Sir George Darwin emphasized the great trend towards specialization among modern mathematicians and referred to the great loss sustained by mathematics in the recent death of Henri Poincaré, who was probably the one man competent to appreciate mathematical research in all its diverse branches. Darwin referred to the Cambridge School of Applied Mathematicians in the last century, mentioning Airy, Adams, Maxwell, Stokes, Kelvin and Rayleigh, and analyzed the characteristic differences in the mental attitudes of the pure and applied mathematician.

The officers of the congress were elected as follows: *President,* Sir George Darwin; *Vice-presidents,* W. von Dyck, L. Fejér, R. Fujisawa, J. Hadamard, J. L. W. V. Jensen, P. A. MacMahon, G. Mitlag-Leffler, E. H. Moore, F. Rudio, P. H. Schoute, M. S. Smoluchowski, V. A. Steklov, V. Volterra; *General Secretaries,* E. W. Hobson and A. E. H. Love.

The congress was organized in four sections devoted, respectively, to arithmetic-algebra-analysis, geometry, applied mathematics and philosophical, historical and didactical questions. The section of applied mathematics was divided into two, one for mathematical physics and astronomy, the other for economics and statistics. This was done also in the case of the fourth section, one section taking up philosophy and history, the other didactics. The international committee having charge of the program appointed the first chairmen of the sections, each of whom gave a short introductory address. The other chairmen were appointed by the sections from day to day.

Section I. Arithmetic, Algebra, Analysis.—The first meeting was presided over by Professor E. B. Elliott, who in his opening address defended the British mathematician from the attacks of those who have said he is too self-centered and cared little for the furtherance of mathematical thought. In the five meetings of this section 28 papers were offered and open for discussion. Many of the papers dealt with that part of the field of analysis which centers about the integral equation. The chairmen for the meetings after the first were Professors E. Landau, E. Borel, E. H. Moore, H. von Koch.

Section II. Geometry.—The chairman of the first meeting, Dr. H. P. Baker, gave a brief survey of the present state of the theory of surfaces and extensions to space of more than three dimensions, and gave reasons for his belief that geometers were now on the threshold of many new discoveries through the mingling of the two streams of investigations associated with the name of the French mathematician Picard and with the modern Italian school. Twenty-four papers were read. The chairmen of the later meetings were Professors F. Severi, F. Morley, J. Drach.

Section IIIa. Mathematical Physics.—Chairman Professor H. Lamb commented upon the division of applied mathematicians into three classes, those whose interests lay mainly in the pure mathematical aspect of the problems of experience, those to whom analysis was only a means towards the interpretation and coordination of phenomena, and those specially represented in the Cambridge school who found a sort of esthetic interest in the reciprocal interplay of experience and theory. Twenty-seven papers were read in this meeting and those presided over by Prince Galatzin and Professors T. Levi-Civita and P. Stäckel.

Section IIIb. Economics, Statistics and Actuarial Science.—Professor F. Y. Edgeworth, presiding at the first meeting, commented on the fact that for the first time this branch of applied mathematics had been given equal rank with the older branches and referred to the pioneering work of Marshall as a mathematical economist and to the importance of the calculus of probabilities in the development of actuarial science. Dr. M. F. Sheppard and Dr. J. F. Steffensen presided at the two last meetings. A total of 13 papers made up the program of the three meetings.

Section IVa. Philosophy and History—Four meetings of this section were held, one a joint meeting with Section IV*b*. Twenty-two papers were offered. The meetings were presided over by Hon. B. A. W. Russell, Professors A. Gutzmer, A. Padoa, F. Rudio.

Section IVb. Didactics.—The first chairman, Mr. C. Godfrey, spoke regretfully of the absence of Klein, who had done so much in promoting the work of the International Commission on the Teaching of Mathematics. The chairman happily characterized the section as devoted to the study of functions of two variables, one being mathematics, the other the student. Three of the five meetings of this section were occupied with the presentation of reports from the various countries to the International Commission. Over 150 reports have been published and 50 more are in preparation. Professors C. Bourlet, J. W. A. Young, E. Czuber, D. E. Smith, R. Fujisawa, were chairmen of the meetings at which ten papers were read. At a special meeting of this section presided over by Sir J. J. Thomson, Professor Runge read a paper on the mathematical education of the physicist which brought forth an animated discussion. Runge's report was made up from the answers received to inquiries sent to universities in many countries, which summed up that need was felt for mathematicians and physicists to draw closer together, more attention should be given to graphical and approximate methods and to numerical computation by mathematical teachers and that instruction in mathematics should be individual. Several speakers in discussing the paper deplored the widening gap between the pure mathematician and the physicist, but it was suggested that the gap should be closed not by compelling mathematical teachers to abandon logical precision, but by discarding things obsolete in the traditional mathematical courses and diminishing the excessive amount of manipulative work which is now demanded from physics students.

Besides the sectional meetings there were ten lectures given at the general meetings of the congress. These lectures were:

"Il significato della critica dei principii nello sviluppo delle matematiche," Professor F. Enriques.

"Periodicity in the solar system," Professor E. W. Brown.

"The history and evolution of arithmetic division," P. J. Harding.

"The principles of instrumental seismology," Prince B. Galitzin.

"Gelöste und ungelöste Probleme aus der Theorie der Primzahlverteilung und der Riemannschen Zetafunktion," Professor E. Landau.

"Définition et domaine d'existence des fonctions monogènes uniformes," Professor E. Borel.

"The place of mathematics in engineering practise," Sir W. H. White.

"Multiply charged atoms," Sir J. J. Thomson.

"Boundary problems in one dimension," Professor M. Bôcher.

"The dynamics of radiation," Sir J. Larmor.

The lecture by Sir W. H. White will no doubt cause a discussion with followers of Professor John Perry for the speaker preferred "pure mathematics taught by a mathematician to the so-called practical mathematics."

From a social standpoint the members were well taken care of. On Wednesday evening, August 21, they were received in the Combination Room and Hall of St. John's College by Sir George Darwin as president of the Cambridge Philosophical Society, and Mr. R. F. Scott, vice-chancellor of the university. On Friday evening they attended a reception at Fitzwilliam Museum given by Lord Rayleigh, the chancellor of the university. Sunday afternoon was given up to a reception by the committee on organization in the gardens of Christ's College. An organ recital was given in King's College chapel on Sunday night. On Monday night the master and fellows of Trinity College received the members in the college. One afternoon was devoted to an excursion to Ely and its cathedral. An excursion to Oxford was arranged for the day after the breaking up of the congress. On this day many accepted the invitation of the Marquis of Salisbury to visit Hatfield House. Facilities were given for visits to the works of the Cambridge Scientific Instrument Making Company, the visitors being entertained by Mrs. Horace Darwin. Visitors to the university observatory were entertained by Mrs. Newall. Besides these, there were many little gatherings and excursions for the ladies who did not care to attend the mathematical meetings. The feature of this congress was the hospitality of the Cambridge colleges. A majority of the members of the congress lived in the colleges and for those of us who were so fortunate, this part of the week's entertainment was one we shall long remember.

On Tuesday a procession was formed and a wreath of laurel and white flowers was carried to and placed on the grave of the Cambridge mathematician, Arthur Cayley, in Mill-road Cemetery. Professor S. Dickstein, of Warsaw, delivered an appreciation of Cayley's work. From the money left over from the subscription for the wreath a memorial of the occasion is to be made in silver and presented to the university.

The congress was well attended, the total number of members registering being 706 from 27 countries. This is somewhat larger than the attendance at Rome in 1904 and much larger than at any other congress. About 85 Americans were present. With the exception of the United Kingdom the United States was represented by the largest number of members, Germany and France coming next in order. At the last meeting the invitation of Professor Mittag-Leffler to hold the next meeting at Stockholm in 1916 was accepted. Invitations to hold the 1920 meeting in Budapesth and in Athens were received, but no action was taken.

A. R. Crathorne

THE NEW ENGLAND GEOLOGICAL EXCURSION

The twelfth annual Geological Excursion of the New England colleges and universities was held in the vicinity of Meriden, Connecticut, October 18 and 19, under the direction of Professor William North Rice, of Wesleyan University, and was attended by representatives from Amherst, Connecticut Agricultural College, Harvard, Mount Holyoke, Massachusetts Agricultural College, Massachusetts Institute of Technology, Smith, Trinity, Tufts, University of Vermont, Wesleyan, Williams, and Yale, teachers of geography from a number of the high schools of Connecticut, about fifty men and women participating.

After a collation at Fisk Hall in Middletown, given by Wesleyan University, the party listened to an illustrated lecture by Professor Barrell, of Yale University, on "Central Connecticut in the Geologic Past" and a brief statement by Professor Rice on the localities to be studied on the following day. After the meeting the party went to Meriden by trolley, where they spent the night. On Saturday morning the party went by special car on the electric line which follows, in general, the line of the Higby Lamentation fault, stops being made to study points of geological interest. A view from a large drumlin afforded an opportunity to recognize the topography resulting from the faulting of the extensive lava sheets of the region—the anterior, main and posterior. A section in the posterior sheet was shown in which what seemed to be the vesicular surface of one flow was covered by the compact lava of a later flow. It was, however, suggested by Professor A. C. Lane that this vesicular lava may have been formed within the lava sheet as is perhaps indicated by its somewhat coarsely crystalline structure. A remarkable section near Westfield, where three faults with their drag dips are well shown, was visited (Bull. VI., Connecticut Geol. and Nat. His. Sur., Fig. 16, p. 213). From here the party walked to other points where drag dips were to be seen and visited the post-glacial Westfield gorge. On account of the rain in the afternoon only a small number ascended Lamentation Mountain. Lunch was served at the Highland Club near Meriden.

The excursion was a most interesting and instructive one, both because it was carefully planned and also because of Professor Rice's lucid explanation of the topographic effects of the great series of faults and the evidences by which the complicated structure of the region was unravelled. The unavoidable absence of Professor W. M. Davis, to whose insight we owe the first clear conception of the relations of the Connecticut traps and sand stones, was greatly regretted.

Herdman F. Cleland

Williamstown, Mass.,
October 22, 1912

THE PAGEANT AT MOUNT HOLYOKE COLLEGE

The festival procession of the liberal arts and sciences presented on October 8 at the seventy-fifth anniversary of Mount Holyoke College was not only a thing of brilliant beauty but to many it was also a dramatic revelation of the round of human knowledge. Planned by the faculty and presented by over six hundred students, it expressed to the audience of three thousand people in a wonderfully impressive manner the salient points in the history and ideals of the eighteen subjects represented. The procession passed for two hours through a natural amphitheater surrounded by trees glorious with unusually gay autumn foliage.

The science division was marked by boldness and effectiveness of treatment, combined with richness of coloring and fineness of detail. Heralds clad in rose and yellow were followed by the personification of "Mathematics, the golden key of the sciences." A striking group of mathematicians represented the history of mathematics from the fifteenth century B.C. to the seventeenth century A.D.

The story of man's progress toward a knowledge of heaven and earth was told by the departments of physics and astronomy. The fire-worshipers of primitive times, and a Chaldean priest studying the stars were followed by a number of the great thinkers and experimenters from Aristotle to Franklin. The material and intellectual gifts to humanity, such as the principle of the conservation of energy, the aeroplane, astronomical time, the telegraph, the steam engine, spectrum analysis, the telescope, the cathode ray, suggesting new concepts of matter, were symbolized by graceful figures suggestively costumed.

The hint of new concepts of matter was echoed in the chemistry section which dealt with the historical development of the chemical element. An aged alchemist, Boyle, Lavoisier, Priestley, Davy and Dalton ushered in a throng of dancers representing the elements. At first mingling in confused and unrelated groups in the wild strains of a Russian folk-dance they fell suddenly into harmony at the bidding of Mendelejeff clad in a Russian robe of black and scarlet. The order of the periodic system and the division of the elements into families was suggested by eight groups of four elements each, the members of each group being dressed in varying shades of one color in the following order, gray, pink, brown, green, yellow, blue, tan and lavender. Then appeared a glittering dancing figure, radium, whose outer robe brilliant with sun-like rays was suddenly cast aside, and gray-gowned helium stood revealed.

A tri-colored banner, brown, green and yellow announced the departments of geology, botany and zoology, their motto being "Dauer im Wechsel," and their subject "Evolution in Nature." The "Sacred Goddess, Mother Earth," Flora from Botticelli's "Primavera," attended by algæ, fungi, ferns, pines and Cattleya orchids, symbolized this thought. Mendel, in monk's garb, followed, accompanied by a group of fruit flies (drosophila) with the characteristic red and white eyes, appearing in the ratio of 3:1 in the second generation.

The entire procession showed marvellous unity of thought as well as artistic blending of color and was pronounced by those who witnessed it to have a tangible educational value as well as the quality of dreamy beauty characteristic of the great pageants of the world.

SCIENTIFIC NOTES AND NEWS

Dr. Andrew D. White, the first president of Cornell University, distinguished for his work in education and diplomacy, and for his publications on history and science, celebrated his eightieth birthday on November 7.

Col. E. E. Markwick, C.B., has been elected president of the British Astronomical Association.

An international conference on time reckoning was opened at the Paris Observatory on October 15 by M. Guist'hau, minister of education; and M. Bigourdan, member of the Institute and of the Bureau des Longitudes, was elected president. The conference has been summoned mainly with the object of dealing with various practical uses of wireless telegraphy in the synchronization of time signals throughout the world.

The Council of the Institution of Civil Engineers has made the following further awards for papers read during the session 1911–12: A Watt gold medal to Professor W. H. Burr (New York), and the Crampton prize to Professor R. J. Durley (Montreal). The following Telford premiums have also been awarded for papers published in the proceedings without discussion during the same session: To Messrs. Paul Seurot (New York), David Anderson, and Harry Cunningham (London), Dr. S. P. Smith (Birmingham), Mr. E. G. Rivers (Richmond), Mr. E. H. Morris (Manchester) and Professor A. H. Gibson (Dundee). The Howard quinquennial prize for 1912 has been awarded to Mr. J. H. Darby (Sheffield), in recognition of improvements introduced by him in iron and steel production, and the Indian premium for 1912 to Mr. H. G. Mitchell (Madras).

Dr. Chester A. Reeds, for four years instructor in geology at Bryn Mawr College, has been appointed assistant curator in the department of geology and invertebrate paleontology of the American Museum of Natural History.

The government of Siam is planning to construct a public system of irrigation and drainage, and has appointed Mr. William Bradley Freeman, C.E. (Cornell, '05), of Denver, director of the project.

The *British Medical Journal* states that considerable progress has recently been made in the organization of the Australian Institute of Tropical Medicine at Townsville, Queensland. Dr. W. Nicoll, of the Lister Institute, and until recently Ernest Hart scholar of the British Medical Association, has been appointed chief assistant; Dr. Priestley, Beit Memorial scholar, an Australian graduate who for the last year has been working at the Lister Institute, has been appointed second assistant; and Dr. Young, assistant chemist at the Lister Institute, biochemist.

The University of Pennsylvania museum's yacht, *Pennsylvania*, is ready for its three-year expedition into the Amazon region. Owing to delay caused by negotiations with the Brazilian government, however, the actual start of the expedition will not be made until late in January. Mr. Algot Lange, head of the expedition, will sail for Rio de Janeiro on December 28.

The Congo expedition of the American Museum of Natural History under the leadership of Messrs. Lang and Chapin reported from Faradje under date of August 21 that the packing of equipment and collections was well under way for the start with caravan for Avakubi and thence out of Africa by the western coast.

Mr. Wilfred H. Osgood, of the Field Museum of Natural History, has returned from a nine-months' trip, during which he crossed the Andes of northern Peru and descended the Amazon River, studying and collecting the vertebrates of the region. Mr. Malcolm P. Anderson, who accompanied him, has remained to continue work in Peru and Brazil.

Mr. J. B. Tyrrell, of Toronto, Canada, has just returned from an extended expedition into the Hudson Bay region. He went northward in the early summer by the ordinary trade route to the mouth of the Nelson River, spent the remainder of the summer on Hudson Bay, and returned from the Bay up the Severn River and by a previously unexplored route across the new district of Patricia to the line of the Grand Trunk Pacific Railway.

Dr. Edward L. Thorndike, professor of educational psychology in Teachers College, Columbia University, will give a course of lectures on the Ichabod Spencer Lecture Foundation at Union College in February and March.

The third of the present series of Harvey lectures will be delivered by Professor Joseph Erlanger, of the Washington University Medical Department, St. Louis, at the New York Academy of Medicine on the evening of November 9, at 8:30. Professor Erlanger's subject will be: "The Localization of Impulse Initiation and Conduction in the Heart."

Professor Burt G. Wilder lectured recently at Smith College on "Louis Agassiz and the Founding of the Laboratory at Penikese."

It is stated in *Nature* that lectures on volcanic action, earth movements, the geological action of water and the evolution of scenery and life on the globe are to be delivered by Dr. Werner Marchand on October 17, 24 and 31, in the meeting rooms of the British Esperanto Association, London. They will be delivered in Esperanto.

Professor Metchnikoff will deliver the Lady Priestley memorial lecture for 1912 on "The Warfare against Tubercle," on November 29, in the lecture theater of the Royal Society of Medicine, London. The lecture will be given in French and illustrated by lantern pictures.

The Chicago Academy of Sciences has announced the following course of public lectures for the fall of 1912:

October 18—"Places of Special Scientific Interest near Chicago," by Dr. Wallace W. Atwood, secretary of the academy.

October 25—"Switzerland and the Alps," by Mr. Edward Marsh McConnoughey.

November 1—"Floral Exhibits in the Academy and how to use them," by Dr. Herman S. Pepoon, of the Lake View High School.

November 8—"The Common Butterflies about Chicago," by Mr. Frank Collins Baker, curator of the Chicago Academy of Sciences.

We learn from *Nature* that a memorial service for the late Mr. H. O. Jones, F.R.S., fellow of Clare College, Cambridge, demonstrator to the Jacksonian professor of natural experimental philosophy, and Muriel Gwendolen Jones, his wife, who were killed in the Alps in August while on their honeymoon, was held at the University Church of St. Mary the Great, Cambridge, on October 12. The service was attended by a large congregation, which included masters of several colleges, university professors and many other members of the university. The Royal Society, the Alpine Club and the Cambridge Alpine Club were also represented.

Dr. Albert N. Husted, who has been connected with the New York State Normal College as student and teacher for fifty-nine years, died on October 16. He would have been seventy-nine years of age had he lived until October 19. His entire life as a teacher was spent in this institution, where he was professor of mathematics, continuing in his work until within less than a week of his death. He was vigorous physically, possessed a charming personality and was greatly beloved by both students and faculty.

Mr. F. H. Low, the honorary secretary of the Röntgen Society, London, has died at the age of fifty-eight years.

Dr. Otto Krümmel, professor of geography at Marburg, distinguished for his work on oceanography, died on October 12, at the age of fifty-eight.

Dr. Paul Second, a distinguished Paris surgeon and professor at the University of Paris, died on October 27.

Dr. Benjamin August Freiherr Afschulten, formerly docent for chemistry at Helsingfors, died at Paris, on September 29, aged fifty-six years.

Hermann Munk, formerly professor of physiology at the veterinary college in Berlin, died in Berlin on October 1. The Berlin correspondent of the *Journal* of the American Association writes of him: "Munk was born in Posen, February 3, 1839, and studied at Göttingen and Berlin as a pupil of Johannes Müller, Hanle, Weber, Du Bois-Reymond, Virchow and Traube. In 1862 he became Privatdozent, and in 1869 professor extraordinary in Berlin. In 1876 he was called as professor ordinary of physiology to the veterinary school, and in 1880 he was appointed a regular member of the Prussian Academy of Sciences, and in 1897 regular honorary professor. After the death of Du Bois-Reymond, Munk was proposed by the Berlin faculty, in the first place, as his successor. The government refused in spite of Munk's prominence, and solely on account of his Jewish denomination, to enter into any transaction with him, a fact which, like many other similar occurrences, does not add to the fame of the Prussian government. In 1907 Munk resigned his office for reasons of health. The number of literary works produced by him is very extensive. When he was a student he delivered at Göttingen an excellent report of research on the finer structure of primitive muscular fibers. In Berlin he wrote a prize work on egg and sperm formation and fertilization of the nematodes. As assistant of Du Bois-Reymond, his studies covered chiefly the general physiology of the nerves and muscles, especially the electric phenomena. His collected pioneer works on the cerebral cortex were published in the eighties under the title 'Ueber die Funktionen der Grosshirnrinde.' His later works treat of the cardiac and laryngeal nerves, cataphonia, milk secretion and the thyroid gland. Munk was an excellent speaker and a beloved teacher, high-minded and modest."

The U. S. Civil Service Commission announce an open competitive examination for alloy chemist, for men only, to fill a vacancy in this position at a salary ranging from $2,400 to $3,000 per annum in the Bureau of Mines, Department of the Interior.

Dr. Rupert Blue, surgeon-general of the U. S. Public Health Service, is making plans to establish a museum or permanent exhibit on sanitation and hygiene. It is one of the duties of the Public Health Service to disseminate knowledge of sanitation and hygiene, and he believes that this can be greatly promoted by such a permament exhibit.

The *Observatory* states that it is proposed to establish an astronomical observatory on Grouse Mountain, British Columbia. Mr. T. S. H. Shearman, director of the Vancouver Meteorological Station, appears to be the originator of the scheme, which has the support of the British Columbia Academy of Science and astronomical and meteorological officials in Canada.

The meeting of the American Society of Naturalists at Cleveland was announced for January 1 and 2, 1913. It is expected, however, that all meetings will be held on the second.

The thirtieth annual congress of the American Ornithologists' Union will convene in Cambridge, Mass., on November 11, at 8 p.m. The evening session will be devoted to the election of officers and the transaction of other routine business. The meetings open to the public and devoted to the reading and discussion of scientific papers will be held at the University Museum, Oxford Street, November 12–14, from 10 o'clock A.M. until 4 P.M. each day.

THE twelfth meeting of the Central Association of Science and Mathematics Teachers will be held at the Northwestern University, Evanston, on Friday and Saturday, November 29 and 30. The Great Northern Hotel, Chicago, has been selected as headquarters for out-of-Chicago members and friends. The addresses at the general sessions will be given by Professor W. C. Bagley, of the University of Illinois, and Carroll G. Pearse, superintendent of public schools, Milwaukee, Wisconsin. The programs of the five sections contain the names of many of the prominent educators of the middle west and provide for many reports and discussions of a practical nature which will prove of great interest and value to teachers of science and mathematics.

THE successful transmission of infantile paralysis in monkeys through the bite of the blood-sucking stable fly (*Stomoxys calcitrans*) has been announced by Professor M. J. Rosenau, of the Harvard Medical School, and C. T. Brues, of the Bussey Institution, Harvary University, and their results have been confirmed by Dr. J. F. Anderson, of the Public Health Service. The hypothesis advanced last year by Brues and Sheppard that the stable fly is the carrier of this disease has thus been given experimental proof, although it is still possible that other channels of infection may exist. With the exception of the investigations of Dr. Anderson, the work was done under the auspices of the Massachusetts State Board of Health.

Nature learns from Greenwich that all attempts to make observations of the recent total eclipse of the sun were frustrated by the heavy rain which prevailed in the eclipse region of Brazil on eclipse day, October 10. The Greenwich observers, Messrs. Eddington and Davidson, were located at Alfenas, an elevated village some 185 miles north of Santos, where there were also eclipse parties from France, Germany, Brazil and other countries. The Brazilian officials rendered all the assistance they could, and the government voted a sum of £5,000 for the reception of the visiting astronomers at Rio.

THE American Association for Study and Prevention of Infant Mortality at its recent Cleveland meeting adopted the following resolutions:

Resolved, That the Association for Study and Prevention of Infant Mortality recommend, in addition to birth and mortality statistics, the collection and compilation of marriage, divorce, industrial and all such social statistics as may have a relation to the problem of infant mortality.

WHEREAS, It has been shown that valuable results have been obtained from the requirement for proper inspection of dairy farms and dairy depots, before granting a permit for the production and distribution of milk, and that the score-card has been of great assistance in recording the observations made at such inspections, therefore be it

Resolved, That the efforts that are being made to secure uniform standards for inspection and uniform methods for recording the results of inspection be approved.

WHEREAS, Constructive housing legislation is made difficult by the absence of comprehensive information relating to infant morbidity and mortality to bad housing, therefore be it

Resolved, That the association emphasize the necessity of such investigation as will, if possible, reduce to a scientific basis the cost of bad housing in terms of infant morbidity and mortality.

THE second season of the Field School of Geology of the University of Chicago was spent in the San Juan Mountains of southwestern Colorado. A party of ten men went into camp near Ouray. After examining several of the mines and milling plants in that vicinity and becoming familiar with the geologic formations and structures around Ouray the party undertook a systematic geological survey of the northeast quarter of the Montrose Quadrangle. The work was extended northeastward into the Uncompahgre Quadrangle and included the study and mapping of a portion of the Black Canon of the Gunnison. The party prepared an areal geological map of about two hundred and fifty square miles. This work was done under the direction of Dr. W. W. Atwood and in conformity as far as possible with the official methods of the United States Geological Survey.

Mr. F. H. Sterns, of the class of 1909 Oberlin College, has been employed by the Peabody Museum of Harvard University to explore an interesting class of prehistoric village sites in eastern Nebraska. A large portion of the archeological specimens collected by the exploration have been presented to the Geological Museum at Oberlin. Mr. Sterns worked in Sarpy County, Nebraska, south of Omaha. The sites evidently belong to a very early stage of Indian occupation and until Mr. Sterns's researches were either unobserved or misinterpreted. They occupied circular depressions popularly supposed to be "buffalo wallows," and thought by Professor Barbour to be the original shape of the sites. It turned out, however, that the structures were square, and that the depressions had assumed their present shape from the deposition of silt, brought in by winds and storms. The collection, which is now being unpacked in the Oberlin Geological Museum, consists of flint and jasper scrapers, knives, arrow heads and the cores from which they had been broken, besides various forms of grooved and polished axes, together with a great variety of ornaments. Some of the arrow shaft smoothers are made from pumice stone which Mr. Sterns concludes has floated down the Missouri River from Montana. The collection constitutes one of the most valuable additions in recent years to Oberlin's already large and valuable archeological material.

In the entire population of the United States illiteracy has declined from 10.7 in 1900 to 7.7 per cent. in 1910, but among children 10 to 14 years of age the decline in the 10 years was from 7.2 to 4.1 per cent. These facts appear in a statement in regard to the illiteracy of children issued by Director Durand, of the Bureau of the Census, Department of Commerce and Labor. The figures are based upon tabulations prepared by W. C. Hunt, chief statistician for population. The general decline of illiteracy marks the improvement of educational opportunities throughout the country, and this improvement is most distinctly measured in comparing the children who have just passed through the schools. Generally speaking, each successive generation in the United States shows a smaller proportion of persons unable to read and write, and this proportion is always least for the children 10 to 14 years of age. Illiteracy is therefore considerably less for children than for the aggregate population. In 1910 the whole number of children of the ages 10 to 14 years who were unable to read and write was 370,120, of whom 144,659 were white and 218,355 negroes, leaving 7,106 among Indians, Chinese and Japanese. Illiteracy among the native white children has fallen to 1.7 per cent., and among those of foreign or mixed parentage who for the most part live in cities, the proportion is as low as 0.6 per cent. On the other hand, as many as 18.9 per cent. of negro children are illiterate. In all classes of the population a marked improvement is noted in comparison with the census of 1900. Illiteracy among white children has fallen from 3.5 to 1.8 per cent., and among the negroes from 30.1 to 18.9 per cent. These figures show that illiteracy in the United States is being gradually eliminated, and that when the present generation of children grows up to manhood and womanhood illiteracy in the United States, especially among the white population, will be no greater than in the most advanced countries of Europe. This striking diminution in illiteracy among children in the last 10 years is found in all parts of the United States, and in the northern part of the country such illiteracy has almost entirely disappeared, as in this section of the country the proportion is considerably less than one per cent. of the whole number of children.

The Registrar-General in his annual summary for 1911, as summarized in the London *Times,* states that in England and Wales the marriages registered last year numbered 274,-577, corresponding to a rate of 15.2 persons married per 1,000 of the population at all ages; the number of births was 881,241, being in the proportion of 24.4 per 1,000 of the population, and the deaths numbered 527,864, or 14.6 per 1,000 of the population. The marriage rate was 0.2 per 1,000 above that in the previous year, but 0.3 below the average rate for the ten years 1901–10. The highest rate in any registration county with a population exceeding 100,000 was 17.8 in London, and the lowest rate was 11.5 in Herefordshire. A decline of 0.7 per 1,000 is recorded in the birth-rate when compared with that for 1910, which was the lowest recorded till then; and last year's rate was 2.8 per 1,000 below the average for the preceding ten years. Among the registration counties Durham had the highest birth-rate, 31.1, and Sussex, with 18.2, was at the other end of the scale. The death-rate was 1.1 per 1,000 above that in 1910, the lowest yet recorded, but was 0.8 below the average for the preceding ten years. The highest rate was 16.8 in Lancashire and the lowest was 11.4 in Middlesex. Of the deaths registered 114,798 were those of infants under one year, 263,481 those of persons between one year and 65 years of age, and 149,585 those of persons aged 65 years and upwards. Infantile mortality, measured by the proportion of deaths under one year of age to registered births, was 130 per 1,000, or 25 per 1,000 above the rate in 1910, and three above the ten years' average. In London the marriages during 1911 numbered 40,201, corresponding to a rate of 17.8 per 1,000 of the estimated population, an increase of 0.5 upon the rate in 1910 and of 0.4 upon the average rate for the five years 1906–10. After distributing the births in the chief institutions receiving maternity cases, the birth-rate in London was 24.8 per 1,000 of the population. This is the lowest rate recorded in the metropolis since civil registration was established. In 1867 the birth-rate in London attained the highest point on record, viz., 36.5 per 1,000 living; since that date the ratio has, with trifling exceptions, fallen steadily. Last year's rate of 24.8 was 0.7 below that in 1910, and no less than 2.7 below the average rate for the ten years 1901–10. The effect of the fall in the birth-rate in London is that, notwithstanding the great decline in the death-rate which has occurred since 1876–80, the natural increase of population by excess of births over deaths, which was then 13.38 per 1,000 living, has now fallen to 9.74. The death-rate in London last year was 15.0 per 1,000, or 1.3 above that in the previous year, and 0.1 above the average for the five years 1906–10. Since the beginning of this century the rate of infantile mortality in London has, with fluctuations, shown a considerable decline. It reached its lowest point, 103 per 1,000 births in 1910, and rose to 129 last year.

UNIVERSITY AND EDUCATIONAL NEWS

WORK has begun on the new graduate school at the University of Pennsylvania, which is to cost $500,000. Money for the school was willed by Colonel James M. Bennett in 1889. There will be dormitories for women as well as men.

FIFTY years after the founding of the School of Mines at Columbia University, or in September, 1914, the Schools of Engineering, its successor, will enter upon a new era and engineering will be placed on the same university plane as law and medicine. Beginning with the academic year of 1914–15 the engineering courses at the university will be composed of three years of undergraduate work, leading up to the degree of bachelor of science; and three years of postgraduate work, leading to the engineering degrees. In order to make adequate provision within the university for students who desire to prepare themselves in three years of college residence for the new courses, a program has been prepared leading to the degree of B.S. The first and practically all the second year will be offered in the present academic year of 1912–13, and the third year may be followed substantially, although modifications may be necessary to avoid conflict with the present courses for candidates for degrees under the old basis, and special programs will be arranged in case of conflict, so that students who desire to begin the new six years course may do so at once without waiting for the full plan to go into effect in 1914.

Dr. F. P. Chillengworth, Hadam, Conn., has been appointed assistant professor of physiology in the University of Kansas.

At Princeton University the following new instructors and assistants have been appointed: James Waddell Alexander, Ray Edwin Gilman and Edward Staples Smith, instructors in mathematics; John Renshaw Carson, instructor in electrical engineering and physics; Keith Kuenzi Smith, instructor in physics; Percy Noyes Edwards, Charles Irving Place and Charles Hurlbut Sterrett, instructors in geodesy.

Dr. Hans Stille, professor of mineralogy and geology at Hamburg Technological School, has accepted a call to Leipzig, as the successor of Professor H. Credner, who has retired.

DISCUSSION AND CORRESPONDENCE

THE FIRST USE OF TRINIDAD PITCH FOR ROAD MAKING

The appearance in *The Popular Science Monthly* for July and August, 1912, of Dr. Clifford Richardson's very interesting and informing article entitled "Trinidad and Bermudez Asphalts and their Use in Highway Construction," leads me to think that the publication of the following account of what is probably the earliest American use of pitch for road making may from an historical standpoint not be devoid of interest. It was found in the course of some other research in Vol. I. of R. Montgomery Martin's "History of the West Indies, comprising Jamaica, Honduras, Trinidad, etc.," which is Vol. IV. of "The British Colonial Library" by the same author. This book was published in 1836. For its use I am indebted to the kindness of Mr. Herbert Putnam, Librarian of Congress.

On page 195, at the close of his description of La Brea, the pitch lake, is found the following footnote:

> I am indebted to the personal courtesy of Major General Sir Lewis Grant, late Governor of Trinidad, for the following facts: "The pitch of the lake has been adopted for the improvement of the roads, particularly in the fertile district of Naparima, where it was brought for the purpose from La Brea. In the wet season the roads at Naparima are almost impassable in those parts where there has been no application of the pitch; but where the pitch has been applied, which is the case for several miles in North Naparima, there is a hard surface formed, which makes transport comparatively easy, both from the support afforded and from the little friction of the hardened pitch."

From the above it may be seen that pitch was used locally for road making in Trinidad some time, possibly several years, prior to 1836, the date of Martin's book. The use of pitch in Europe, so far as the present writer has been able to ascertain, but little antedates the above. Eirinus, a Greek physician, made use in 1712 of asphalt from the Val de Travers, Neuchâtel, Switzerland, as a coating for both stone and wooden walls to protect them from decay caused by insects, changes of temperature and weather. He knew of its use in Babylon as an ingredient of mortar, and seems to have used it in the same way as a lining for cisterns and as a coating for walls and floors of warehouses. However, it seems to have been first used as a road material by Count de Sassenay, who obtained his material from the same source as Eirinus and made use of it on the roads of France as early as 1832. This seems to have been rock or block asphalt. Rock asphalt was used in paving the streets of Paris in 1838, but not on a large scale until 1854. The same material was first used on the streets of London in 1869. The first pavements of this material in the United States were laid in Newark, New Jersey, in 1870. The following year saw streets in New York paved with asphalt and shortly thereafter Philadelphia followed suit. These three cities all made use of Trinidad asphalt in the rock (*i. e.*, presumably block) form. However, its use as a paving material on a large scale in the United States began with the rehabilitation of the streets of our national capitol, Washington, in 1876–77. Here both rock and sheet asphalt were laid, the latter so successfully that its use has become widespread throughout the world.

It is commonly believed that the Incas of Peru made use of asphalt in building roads, but no evidence has ever been found to sustain that belief, and recent travelers have seriously questioned the excellence of those roads.

That asphalt was known to the ancients is a well-attested fact, its use as a binder for masonry in Babylon being in point, but of its use other than this we know nothing. Strabo tells us that as early as 2000 B.C. the streets of Babylon were paved, and so, too, presumably were the great roads leading out from the many gates of that city. Babylon was situated in the alluvial plain of Mesopotamia and its building material was almost entirely clay, either as such or in the form of bricks. It seems rather doubtful that these latter were used to pave the streets at that early date. Asphalt was abundant and much used in building operations, and it does not seem improbable that it was utilized to improve the streets. However, this is conjecture, for none of the reference books at hand contain any record of its use as a road-making material in those far-distant times.

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THE "WILLIAMS' PROCESS" OF PHOTOGRAPHY

To the Editor of Science: It may be of interest to your readers to know that as of July 1, 1912, there has been dedicated to the free use of science and scientists the patented process for photographic illustrations (U. S. Pat. No. 640,060), owned by the undersigned and known among paleontologists, who found it especially useful in specimen work, as the "Williams' Process." In brief, it consists in the deposition by sublimation on the object to be photographed of an extremely tenuous monochrome film for the purpose of obviating the reflection, refraction and distorted shadow values common in ordinary photography of certain classes of objects.

It has been a matter of great regret to the writer that a long-continued and expensive investigation, arising out of an entirely legitimate difference as to the scope and validity of the patent, has delayed until now the fulfillment of the original intention of the writer to make this dedication so soon as the expenses incurred in perfecting and establishing the patent should have been secured by the moderate royalties hitherto charged. The outcome of the controversy has entirely justified the writer's position: the opinion of the opposing experts conclusively confirming the fundamental character of the invention.

As one interested in science, the writer would have been pleased if his means had permitted the assumption of all the expenses of this patent without thought of recoupment, and is heartily sorry that there are those who felt that the failure to do so is culpable. If it is so, I can only plead that it is so in violation of no code with which I am familiar.

In view of the fact that the invention was originally made by my honored father, Dr. Henry Shaler Williams, of Cornell University, it is most desirable that certain facts be stated for the benefit of those who may in the past have been under a misapprehension as to his relation to the patent. Almost immediately after being granted the patent was transferred from him to me in good faith and in consideration of the assumption of debts incurred in its development. My father's wish always has been that the process should be made freely available to science gratis, and I promised him it should be as soon as its financial situation could be cleared up. It has never yielded a cent of profit to Henry Shaler Williams, nor was it taken over or ever handled with the idea of exploiting science or making commerce of its needs. This can not be stated too strongly. With the long-drawn-out controversy referred to my father has not only had nothing to do, but has repeatedly endeavored to induce me to abandon it.

Therefore the blame in the matter, if blame there be, is entirely mine and I cheerfully shoulder it; but he should be given complete exoneration from any such charge. Those who have been disposed to think critically of

Dr. Williams in connection with the patent have been doing a great and unwarranted injustice to a high-principled man, whose character and whose long and disinterested devotion to science should have made it unnecessary to break the silence he has long maintained, as I now do, without his knowledge, to right a wrong; and, as I sincerely hope, to remove completely any ground for misgiving on the part of any one of his many distinguished friends toward a loyal and worthy colleague.

ROGER H. WILLIAMS

SCIENTIFIC BOOKS

Heredity and Eugenics. A course of lectures summarizing recent advances in knowledge in variation, heredity and evolution and its relation to plant, animal and human improvement and welfare. By WILLIAM ERNEST CASTLE, JOHN MERLE COULTER, CHARLES BENEDICT DAVENPORT, EDWARD MURRAY EAST, WILLIAM LAWRENCE TOWER. The University of Chicago Press. Chicago, 1912. Pp. viii + 315. $2.50 net, $2.70 postage paid.

In view of the great leap which the study of genetics has taken in the past decade, and the notable contributions which are made almost daily, both in facts and in theories, it is hardly surprising that general systematic texts in the subject are not forthcoming at this time. Instead we have treatises of special phases of the subject, such as Mendelism or eugenics, and the publication of lectures, which are usually general summaries of more or less wide scope, attempting to keep abreast the times. Such a series of lectures delivered at the University of Chicago in the summer of 1911 is now presented to the public in book form. Considering the fact that "the lectures were given by five lecturers, with no opportunity to relate the lectures to one another other than as suggested by the assigned titles," the book, as a whole, presents a rather surprising unity, though somewhat lacking in balance and by no means covering uniformly the range of the subtitle. This, however, could not be expected under the circumstances, and the explanation in the preface disarms this criticism.

We are told that these lectures "were not intended for those trained in biology, but for a general university audience, interested in the progress of genetics as a matter of information rather than of study. The lecturers, therefore, did not address themselves to their colleagues. . . ." One familiar, however, with the "general university audience" not trained in biology, and with the difficulty the average student has in absorbing a working knowledge of such phenomena as dihybridism and multiple factors, is inclined to suspect that unless the lectures were supplemented with "asides" which are not included in the text, the "colleague," or at least the person who had made some previous study of the subject, carried more away from them than the person without preparatory biological training. It is safe to say that the comparatively small amount of repetition which occurs will prove no detriment to the general reader.

Professor Coulter undertakes the rather thankless task of paving the way for the real procession, which is to follow. In the first two chapters, dealing with "Recent Developments in Heredity and Evolution: General Introduction" and "The Physical Basis of Heredity and Evolution from the Cytological Standpoint," he has done this in an orthodox, but on the whole very clear and interesting, manner. The relation of the processes of inheritance to evolution, plant and animal breeding, and to eugenics, is pointed out and a cytological basis supplied upon which the Mendelist may hang his interpretations without compunction. Coulter, unlike many cytologists at the present time, evinces no hesitancy in placing upon the chromosomes the burden of hereditary transmission (p. 32).

In the third and fourth chapters Professor Castle treats of "The Method of Evolution" and "Heredity and Sex." These chapters are very similar to parts of the same author's recent book,[1] which is itself a series of lectures

[1] "Heredity in Relation to Evolution and Animal Breeding." D. Appleton & Co., New York, 1911.

rather than a text; but perhaps nowhere has he stated more clearly his position with respect to the methods of evolution. In this, as rather opposed to the present tendency, he stands with Darwin in his belief that the selection of small fluctuating variations has been a more potent factor in evolution than distinct genetic mutations. In other words, he believes in the changeability or modifiability of "unit-characters"—we wonder if it is with intent aforethought that he does not say "unit-factors"? From a purely logical standpoint, however, it is difficult to see why those cases which Castle adduces in support of the changeability idea—the polydactylous race of guinea pigs and the color-pattern series in rats (pp. 56–61)—are not capable of the same explanation as the size of the maize ear (pp. 54–56), in which case Castle accepts East's explanation of a number of independent factors. Castle states his position succinctly in the last paragraph of Chapter III. (p. 61), which is accordingly worth quoting in full:

"Accordingly we conclude that unit-characters are not unchangeable. They can be modified, and these modifications come about in more than a single way. Occasionally a unit-character is lost altogether or profoundly modified at a single step. This is mutation. But more frequent and more important, probably, are slight, scarcely noticeable modifications of unit-characters that afford a basis for a slow alteration of the race by selection. Mutation, then, is true, but it is a half-truth; selection is the other and equally important half of the truth of evolution, as Darwin saw it and as we see it."

Leaving aside the restricted use of "selection" in the above paragraph—for the strictest mutationist could scarcely dispense with selection as an operative force in evolution—interest centers on the question of the modifiability of unit-characters. In Chapter V., "Inheritance in the Higher Plants," Professor East takes up this point, and maintains that the instability of unit-characters does not affect "the truth of the genotype conception as a help toward an idea of the process of heredity." If Castle means by "unit-characters" the "personal qualities" of Johannsen, it would seem that East has justification in his opinion that their views are not incompatible.

One hears much criticism of Mendelists on the ground that they are too ready to think of "factors" as material things, to regard genetic formulæ as representing actualities, and to juggle with increasingly complicated theories which have no secure foundation. While it is true of all theorizing that there is danger in the joy of construction of forgetting flaws in the basic premises, this is really a criticism of individual method. Every worker should make his own reservations, however much he may try to fit his facts to this or that theory. East, who is perhaps as dyed-in-the-wool a Mendelist as there is in this country, shows commendable caution when he sums up the essentials of Mendelism in the following words (pp. 89, 90):

"Stated in fewer words, the essential feature of Mendelianism is the segregation of potential characters in the gamete in a state of apparent purity, and their recombination by the law of chance through random mating. The term 'Mendelian notation' was therefore used advisedly. Mendelian notation is a simple *interpretation* of certain *facts* of heredity *obtained in pedigree cultures.* It is a convenient notation and is used much as the element symbols are used in chemistry. *It makes no difference to analytical chemistry whether or not an atom is a reality, for the law of 'Definite and Multiple Proportions' upon which analytical chemistry is based is still valid.* In the same way it makes no difference whether one regards unit-characters as actual units and their segregation as complete, or whether one sees in organisms a mutual dependence between characters and a quantitative or partial segregation among gametic factors, the notation is useful either way to make clear the facts of heredity as shown by actual experiment."[2]

Chapter V., from which quotation has just

[2] Italics not in original.

been made, reviews the facts of Mendelism, using plant subjects as illustrations, and introduces some of the more complicated cases. In his second chapter, which considers "The Application of Biological Principles to Plant Breeding," East treats the subject in much the way he did in his earlier valuable bulletin.[3] Perhaps most interesting in the chapter is his discussion and presentation of the evidence for the stimulating effect of crossing.

By far the longest chapter is the sixth (more than a third of the whole book), by Professor Tower, on "Recent Advances and the Present State of Knowledge Concerning the Modification of the Germinal Constitution of Organisms by Experimental Processes." One feels that for general, and professedly non-technical, purposes this chapter would have been improved by the omission of much of the detail of the author's own experiments and a clear statement of the results. Certainly in its present form it does not hold the interest of the reader to an equal degree with the other chapters, and it is difficult to see how a non-biological audience can have followed the detail in the lectures. Tower sums up the evidence to prove that the "impinging of incident forces" upon the germ plasm may modify the germinal constitution of organisms, but combats "the hypothesis of the peripheral origin and transmission of variations," otherwise spoken of in common parlance as "the inheritance of acquired characters." Tower apparently does not, however, consider the fact of possible direct modification of the germinal constitution inimical to Mendelian interpretation.

Chapters VIII. and IX., by Dr. Davenport, contain much of the interesting material given in his recent book on eugenics.[4] The former, entitled "The Inheritance of Physical and Mental Traits of Man and their Application to Eugenics," is largely a catalogue of the method of inheritance of various traits in man, accompanied by family charts by way of illustration. In the second of his chapters are discussed, with concrete examples, the effects of segregation and migration and their eugenic significance, followed by the inevitable "Edwardses" and "Jukes" as examples of the descent of good and bad single lines of germ plasm.

There is little need to call attention to minor inaccuracies in a book of this nature, which really are few. The typography and proof-reading are good. On pages 124 and 125 there was noticed some confusion in referring to figures 53 and 54.

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[3] "The Relation of Certain Biological Principles to Plant Breeding." By Edward M. East, Ph.D. Conn. Agr. Expt. Sta., Bull. 158, 1907.

[4] "Heredity in Relation to Eugenics." By Charles Benedict Davenport. Henry Holt & Company, New York, 1911.

A Handbook of Sugar Analysis. A Practical and Descriptive Treatise for Use in Research, Technical and Control Laboratories. By C. A. Browne, Ph.D., chemist in charge of the New York Sugar Trade Laboratory. New York, John Wiley and Sons. 1912. Cloth, $6.00 net. Sugar tables separate, cloth, $1.25.

Dr. Browne's volume is the latest and certainly one of the most noteworthy publications by which the literature of the sugar-industry has been enriched within the past decade.

The author presents not only a very full selection of the most approved methods of sugar analysis, but offers—as he is most eminently qualified to do—account of the applicability and limitations of the various methods discussed.

On this account the work is of value not only to the chemist who is entrusted with the supervision and control of the laboratory of a working plant, and who, above all things, seeks to place his finger on the most accurate and practical methods of analysis, but also to the student and worker who desires to understand thoroughly the principles and theory underlying such methods.

The volume is divided into two parts. The first part is given over to a consideration of physical and chemical methods of sugar analysis; the second part, to the occurrence, preparation, properties and reactions of the sugars and their allied derivatives.

Part I., which covers about 500 pages, discusses the sampling of sugars and sugar products; determination of moisture; densimetric analysis; the refractometer and its applications; theory and practical application of polariscopes; the specific rotation of sugars; methods of simple and invert polarization; qualitative methods for the identification of sugars, and methods for the analysis of sugar mixtures.

Part II., in some 260 pages, deals with the formation of sugars in nature, and their classification; the mono-, di-, tri- and tetrasaccharides, the amino-sugars, cycloses and the sugar alcohols and sugar acids.

The sugar-tables, which, for convenience, are grouped together in an appendix of 100 pages, are paged independently of the rest of the volume. They may therefore be bound separately for laboratory use.

An idea of the painstaking care with which this work has been prepared may be gained from the fact that the index alone fills 69 pages. The style in which the book is written is admirably clear and concise; the merits and demerits of the various methods given are objectively and dispassionately stated; the methods endorsed by the International Commission for Uniform Methods of Sugar Analysis—of which Commission Dr. Browne is a member—receive full consideration throughout. The text is illustrated by a number of well-chosen and well-executed cuts, and the general excellence of the typography and make-up of the book reflect great credit on the publishers.

Dr. Browne is certainly entitled to the most cordial appreciation and congratulations of his fellow-workers on this classic contribution to their store of knowledge.

F. G. Wiechmann

Popular Guide to Minerals. By L. A. Gratacap. New York, D. Van Nostrand Company. 1912. 330 pages, 74 plates and 400 figures. Price $3.00.

This book, as its name indicates, is intended chiefly for the general reader and student. It is designed largely to assist in the study and appreciation of the mineral collections to be found in our great museums. It is to be regretted that popular interest in minerals is by no means as widespread or as active to-day as it was twenty-five years ago and it is to be hoped, therefore, that this book may help to revive the study of minerals and to restore it to its proper place as one of the more interesting and popular branches of natural science.

The book contains a section on crystallography, followed by a discussion of the physical and chemical properties of minerals. The section devoted to the description of mineral species—in harmony with the purpose of the book—has been entitled, "Guide to Collections." An extensive history of the development of mineralogy follows and the book closes with a description of the fine Bement mineral collection which belongs to the American Museum of Natural History in New York City and of which the author of the book is curator.

The illustrations comprise first a series of more than seventy plates giving photographic reproductions of some of the finer and more striking specimens in the Bement collection. Mineral specimens offer many obstacles to successful reproduction in this way and nothing but praise can be said of the results achieved. It is to be regretted that the line figures used in the book, especially in its earlier sections, have not been reproduced as successfully.

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SPECIAL ARTICLES

ANTAGONISTIC ACTION OF ELECTROLYTES AND PERMEABILITY OF THE CELL MEMBRANE

1. The writer observed years ago that the newly fertilized eggs of *Fundulus* die in a 5/8 *m* NaCl solution without forming an embryo, while the addition of a very small but definite amount of a salt with a bivalent metal (with

the exception of the heavy metals) caused them to live and form an embryo.[1] Seven years ago he formulated the hypothesis that this antagonistic action of salt was primarily due to the fact that the solution of only one salt in a sufficiently high concentration alters the membrane of the cells, thereby increasing its permeability, while this increase can be inhibited through the addition of the antagonistic salt.[2] In a recent paper a summary of the facts supporting this hypothesis was given.[3] According to this hypothesis, the pure NaCl solution slowly increases the permeability of the membrane, diffuses into the egg and kills the germ, while the addition of a small amount of $MgCl_2$, $CaCl_2$, $SrCl_2$, $BaCl_2$, etc., inhibits or retards this increase of the permeability and the death of the embryo. During the last year Osterhout has published confirmatory experiments on *Laminaria*.

This summer the writer has found a new method by which it was possible to test the validity of this hypothesis for the egg of *Fundulus*. This egg has a considerably higher specific gravity than sea water. It will float in a 12/8 *m* NaCl solution but not in a 11/8 *m* NaCl solution. The method consisted in putting the eggs into solutions of a higher specific gravity than that of a 12/8 *m* NaCl solution and observing how long they will float in such a solution. For these experiments eggs were used which had been fertilized at least three or four days previously. The following striking facts were found. If the eggs are put into a 3 *m* solution of NaCl they will float, but as a rule not longer than three hours. Then they will sink to the bottom of the test tube. Before sinking they lose water as is indicated by the collapse of the membrane and the shrinking of the yolk sac. Probably some NaCl enters into the egg. When we put eggs into a 10/8 *m* solution of $CaCl_2$ they float at first, but will sink in about 1/2 hour. If we use $CaCl_2$ solutions of a still higher concentration the eggs will shrink and fall to the bottom just as fast or still faster. If, however, we put the eggs into a mixture of 50 c.c. 3 *m* NaCl + 2 c.c. 10/8 *m* $CaCl_2$ they will float three days or longer at the surface of the solution. During this time the eggs do not shrink at all or very little and the embryo keeps alive. In a mixture of 50 c.c. 2 1/2 *m* NaCl + 1 c.c. 2 1/2 *m* KCl + 0.75 c.c. 2 1/2 *m* $CaCl_2$ some of the eggs floated on the surface as long as ten days, while in a 2 1/2 *m* solution of NaCl they did not float more than a few hours. The only possible explanation of these experiments is that the membrane of the eggs of *Fundulus* is practically impermeable to water and to salts in a physiologically balanced solution. If the egg, however, is transferred to a hypertonic non-balanced solution the natural impermeability of the membrane is gradually lost and water will diffuse out of the egg and its specific gravity increase to such an extent that the egg sinks.

When the eggs are put into pure solutions of each of the following salts, $MgCl_2$, $SrCl_2$, $BaCl_2$, above a density of 1.0634 the eggs will float at first but will shrink and fall to the bottom in less than an hour; the sinking begins the more rapidly the higher the concentration. This indicates that the higher the concentration the more rapidly does the salt increase the permeability of the membrane for water. If, however, a small but definite amount of any of these salts is added to 50 c.c. 3 *m* NaCl the eggs will float on the 3 *m* NaCl solution for a considerably longer time than if no salt with a bivalent metal is added. These experiments show that the toxic or injurious action of the pure NaCl solution observed in my experiments on the *Fundulus* egg was due to an annihilation of the specific impermeability of the membrane of the egg through the action of NaCl and the subsequent entrance of this salt into the egg, and that the antagonistic action of the salts with bivalent metals was due to the fact that they inhibited the increase of permeability of the membrane for salt and water.

2. In 1899 the writer published the fact that the addition of a sufficient amount of acid causes the muscle of a frog to swell in an

[1] *Pflüger's Archiv*, 88, 68, 1901; *Am. Jour. of Physiology*, 6, 411, 1902.

[2] *Pflüger's Archiv*, 107, 252, 1905.

[3] Science, 34, 653, 1911.

$m/8$ NaCl solution; that the muscle also begins to swell after some time in a neutral hypertonic NaCl solution, while it shrinks in a sufficiently hypertonic NaCl solution if the latter is rendered acid. He ventured the suggestion that this might be a protein reaction.[4] This suggestion has since been amply corroborated by the work of Hardy, Procter and Pauli. It was, moreover, found that this antagonism between acid and salt is much stronger for the system $H_2SO_4 — Na_2SO_4$ than for the system HCl — NaCl.[5]

These data were utilized to find out whether the specific impermeability of the membrane of the egg of *Fundulus* is due to lipoids or to proteins. It was found that when eggs are exposed to a $N/333$ solution of acetic acid for twenty minutes, their permeability increases to such an extent, that if they are put into a mixture of 50 c.c. 3 *m* NaCl + 1 c.c. 2 1/2 *m* $CaCl_2$ they sink in less than seven hours (while the normal eggs float in such a solution for three days). If, however, the acetic acid solution is made up in $m/2$ NaCl (instead of distilled water) an exposure of the eggs of twenty minutes or more to the acid solution does not injure the membrane. Such eggs will float in 50 c.c. 3 *m* NaCl + 1 c.c. 2 1/2 *m* $CaCl_2$ three days or longer. By the same method it was ascertained that in the system $H_2SO_4 — m/2\ Na_2SO_4$ the action of the acid was more effectively inhibited than in the system HCl — NaCl. From these experiments we are inclined to conclude that the increase in the permeability of the membrane for water and salt under the influence of acids is due to an alteration of the protein constituents of the membrane.

3. It was found that alcohols also increase the permeability of the membrane of the *Fundulus* egg for water (and possibly for salts). If eggs are put for sixty minutes into a grammolecular solution of methyl alcohol and then transferred to the test solution (50 c.c. 3 *m* NaCl + 2 c.c. 10/8 *m* $CaCl_2$) they will sink in less than eight hours (while the normal eggs float three days at the surface of such a solution). The relative efficiency of various alcohols for bringing about this increase in the permeability of the eggs was ascertained and it was found that each higher alcohol of the series is about three times as efficient as the preceding one. This is the well-known relation indicating effects on lipoids. The facts mentioned sub. 2 and 3 agree with the suggestion made by Natanson that cell membranes may be a mosaic of proteins and lipoids.

4. The increase in permeability caused by electrolytes and by alcohols is reversible if the eggs are put into sea water or into a $m/2$ solution of NaCl + KCl + $CaCl_2$ in the usual proportion. If the eggs are put into distilled water they may continue to live, and the fish may hatch, but the increase in permeability is not reversed. It can be shown that distilled water itself increases the permeability of the membrane very slowly.

JACQUES LOEB
ROCKEFELLER INSTITUTE,
NEW YORK,
October 22, 1912

[4] *Pflüger's Archiv*, Bd. 75, p. 388, 1899.

[5] Beutner, *Biochemische Zeitschrift*, Bd. 39, 280, 1912.

VITAL STAINING OF CHROMOSOMES AND THE FUNCTION AND STRUCTURE OF THE NUCLEUS

ONE difficulty in studying protoplasm, particularly of living mitotic figures, is due to the slight differences in the refractive index of the various structures in the living cell. Up to the present, no satisfactory study has been made on the living chromosomes.

Our studies have been confined chiefly to the testes of the squash bug, grasshoppers and crickets, which are very favorable on account of the large size of their cells, and the clearness of the nuclear figures.

The testes were teased in Ringer's fluid and stained with Janus green (diethylsafraninazodimethylanalin) and studied in hanging drops in the Barber moist chamber. By variations in the concentration of the dye beautiful differential staining of the various cellular elements was obtained.

Masses of cytoplasmic granules varying in their position in the spermatogonia, spermatocytes, spermatids and spermatozoa were stained a deep blue. The nuclear network of these cells and the chromosomes and spindle fibers, in all the division stages, were brought out with great sharpness by a somewhat longer application of the dye.

The separation of the dyad chromosomes in the metaphase figure of a primary spermatocyte of *Anasa* was observed. The transformation of anaphase figures of both spermatogonia and spermatocytes to telophase figures was easily followed.

When diethylsafraninazodimethylanalin is reduced the color changes from blue to red.

The possibility of studying nuclear reductions at once became apparent, when it was demonstrated that the stained chromosomes continued to live. By the use of appropriate methods we have been able to follow the relative rate of reduction in the nucleus and cytoplasm.

In the spermatid the first structure to turn red was found to be the "Nebenkern." Later all parts of the cell show this change. In the cells showing division figures the chromosomes and spindle fibers began to turn red while the remainder of the cell was still a deep slate blue. The same was found to be true for the nuclear network of resting cells. In the final stage of reduction, all stained cellular structures are red.

The colloidal structure of the resting and dividing nucleus was studied by means of dissections. The cells, in hanging drops, were dissected with Jena glass needles held in a three-movement pipette-holder. The needles were drawn in many cases to less than one half micron in diameter and the dissections were made under a 2 mm. Zeiss objective and Nos. 6 and 8 compensating oculars.

Resting and dividing spermatogonia, spermatocytes, spermatids and spermatozoa were dissected. Resting epithelial cells from the skin of the *Amblystoma* larva were also dissected.

The living cytoplasm of the spermatogonium, spermatocyte, spermatid and spermatozoon is extremely glutinous. It frequently adheres to the minute glass dissecting needle and a large portion of it can be drawn out into strands. This is particularly true of the spermatozoon. Dissections are greatly increased in difficulty, on account of this fact. Dying cells lose their viscidity and may be easily torn to pieces.

The masses of minute cytoplasmic granules, stained by Janus green, the "Nebenkern" and the middle piece of the spermatozoon, do not readily go into solution when dissected out in Ringer's fluid. Puncturing and tearing away parts of the cytoplasm of the spermatogonium and spermatocyte have no appreciable effect on the nucleus. When the cytoplasm or nucleus is punctured, the area immediately surrounding the needle stains a deep blue. If a portion of the nucleus be torn away the remainder does not collapse and gives no evidence whatsoever of loss of substance. The nuclear network can be torn out and is found to be a fairly concentrated, elastic gel, imbedded in a much more dilute viscous gel. Metaphase and telophase spindles neither collapse nor go into solution when freed from cytoplasm.

Single chromosomes were dissected out of cells in the prophase, metaphase and telophase stages. The chromosome is a fairly concentrated and somewhat refractive gel. It varies in elasticity in its different phases. A single metaphase chromosome was dissected out with its spindle fiber attached. The spindle fiber is a slightly refractive elastic gel and in the metaphase it seems to be continuous with the chromosome.

The nuclear network, spireme, spindle and chromosomes are imbedded in a dilute glutinous gel that is commonly invisible by the usual microscopical examination.

In two cases, while attempting to separate the daughter cells of a spermatocyte in telophase, a partial rapid reversal of the chemical and morphological changes occurring in cell-division was observed. In two seconds the daughter cells had fused and formed a single cell; the spindle fibers formed an irregular network in which the chromosomes were entangled. These observations seem to indicate that cell division is allied to contactility.

Resting epithelial cells from the skin of the *Amblystoma* larva were dissected for comparison. These cells are quite elastic. If a portion of the cytoplasm or nucleus be cut away, the remainder of the cell undergoes no demonstrable change in form. There is no evidence of a loss of substance from the nucleus when it is cut or torn. The nucleus in this cell is a quite concentrated gel. The intercellular matrix is non-viscous and highly elastic.

Extended studies in this field will be published later.

G. L. KITE
ROBERT CHAMBERS, JR.
THE MARINE BIOLOGICAL LABORATORY,
WOODS HOLE, MASS.,
September 25, 1912

EXPERIMENTS WITH DESICCATED THYROID, THYMUS AND SUPRARENALS[1]

THIS preliminary study of the effects of feeding the desiccated endosecretory organs was made on rabbits, guinea-pigs and fowls during June, July and August of the present year. The chief aim was to determine what proportion of the offspring of females given an excess of the dry substances were viable. The proportion of deformed offspring is not significant, but the action of the drugs on the fetuses and sucklings seems worthy of a brief note.

RESULTS IN THE PREGNANT RABBITS

Drug	Females	No. of Offspring	Deaths						Killed for Study on 4th Day
			At Birth	1 Day	2 Days	3 Days	23 Days	Living	
Thyroid..	4	24	2	10	3	6	1	2	
Thymus..	4	22	10			5		7	
Suprar. . .	1	11				2*		9	
Control...	1	10						6	4

From four to ten capsules (.76–1.9 gm.) of thyroid were given daily to rabbits during the last 20 days of their pregnancy, with no apparent symptoms of thyroidism. The offspring, however, either died at birth or during the first three days of lactation. Before their pregnancies it was found that from .38 gm. to .57 gm. of thyroid sufficed to produce extreme diarrhea and very rapid heart action; no exophthalmos developed. Weight decreased rapidly with .57 gm.

It was noted that if the offspring were not dead at birth and the heavy doses of thyroid were discontinued during lactation, the offspring lived.

In the case of one female of this thyroid group, preliminary feeding with thyroidectin had taken place until six days before parturition, when doses of thyroid increasing from .38 gm. to 1.52 gm. per diem were administered by the capsule method. The lactating young were killed on the third day of this treatment, although they had gained somewhat in weight during that time.

In the case of the thymus-treated females, the resistance to heavy doses (2.16–2.17 gm.) during the latter half of pregnancy also held. The offspring of three females were killed by the drug at an early age; one litter of the fourth succumbed at the third day of lactation, the other litter was born two days after the cessation of thymus feeding and though smaller than either of the two litters of the control rabbit in this series, lived. The effects of thymus on the adult females not in the later stages of pregnancy were similar to those in the non-pregnant females.

Unfortunately, but one of the suprarenal-fed rabbits gave birth during my period of experimentation. Her young were alive on the twenty-fifth day after birth, having grown much more rapidly than those of the control. Two of this litter were placed with one of the thymus females whose young had just died, on the day after birth, and two days later were dead. A third suckling from the suprarenal female was placed with the thyroid female which was receiving diminished doses during lactation, and this last adoption was successful also, but with the result that the stranger grew 5 gm. more in two days than a brother with the same initial weight in the home nest.

No discussion of these facts is needed; the table speaks for itself. These females were

[1] From the Station for Experimental Evolution, Carnegie Institution of Washington.

not pregnant during the first 31 days, when these records were kept. The certainty of this condition is known, for the animals had not brought forth young at the end of 68 days of observation.

RESULTS IN THE NON-PREGNANT RABBITS

Drug	Dose	Rabbit's Number	Effect
Thymus..	.270–1.08	III.	1.08 produced illness.
Suprar. ..	.54 –2.16	VI.	Steady increase in weight.
Suprar. ..	.54 –2.16	VIII.	Steady increase in weight.

Owing to the scarcity of guinea-pigs at the time we attempted to secure them, work was carried on with but five females. The same apparent stimulating effect of suprarenalin on the growth and well-being of the adults and young was noted in two of these females. The data of this group are not complete.

Average Dose of Drug	Effects on the Body-weights of Fowls	
	Weight at Beginning of Exp't, Kg.	Weight After 10 Days, Kg.
.355 g. thyroid....	1.574	1.35
.355 g. thyroid....	1.476	1.378
.355 g. thyroid....	1.574	1.574
.39 g. suprar.....	1.4414	1.23
.414 g. suprar.....	1.294	1.150
.39 g. suprar.....	1.180	.972
.776 g. thymus....	1.66	1.66
Control..........	1.180	1.180

The fowls exhibited no symptoms of discomfort or illness during treatment.

Eggs were secured from the fowls treated, but their paucity and the infertility of a large proportion of both the eggs of drugged hens and the control fowl render the data scarcely worth considering.

We may conclude from this study that

1. Thyroid fed in considerahle quantities to pregnant female rabbits produces weakness in the offspring.

2. Thymus is similar in its effect on the offspring.

3. Suprarenalin does not hinder development in the rabbit, but appears to slightly accelerate growth.

4. Thyroid and thymus are most injurious to the suckling rabbit.

5. The fowl is not materially affected by doses of thyroid and thymus which produce diarrhea, tachycardia and alopecia in the rabbit.

F. E. Chidester
Cold Spring Harbor,
Long Island, N. Y.,
September 10, 1912

NOTICE OF NEWLY DISCOVERED EURYPTERIDS IN NEBRASKA

A bed of Eurypterids has just been discovered by the Nebraska Geological Survey in the Carboniferous shales of southeastern Nebraska, and thus a new locality is added to the list for the United States. Such localities are somewhat rare, and notice of any and every new one must be acceptable.

The Carboniferous outcrops are confined to some eight or ten counties in the extreme southeastern corner of the state, and though covered heavily by glacial clays, bold exposures occur in proximity to the bolder streams, especially the Missouri River. About a mile south of Peru, on the Missouri River front, the bluffs are limestones interbedded with thin layers of shale. But within a few hundred feet the shale thickens until the limestone pinches out altogether, and within as many feet the shale becomes increasingly arenaceous until it merges into a bed of massive cross-bedded sandstone. Within a mile this order is symmetrically reversed.

About one and a half miles south of Peru and immediately at the side of the Burlington track, and some thirty feet above the river, there occurs in this massive sandrock an irregular bed about a foot thick comprising alternating bands of sand and thin layers of compact slate-colored shale. These shale seams are seldom thicker than a quarter of an inch. They cleave readily and expose surfaces covered by innumerable leaves, stems, and their fragments. *Neuropteris* pinnules, and stems of *Calamites* are abundant.

Associated with these are the newly discovered Eurypterids. From observation in the field they seem to be adults, and yet they are diminutive, measuring but 1½ inches (38 mm.) in length. They appear to be fairly plentiful, for seven individuals were found on a space less than one yard square. They are well preserved and, in the case of one at least, the anatomy can be worked out in detail even to the joints of the appendages.

Apparently there are three distinct forms, which probably represent as many species, and at least two genera. If study substantiates the belief that these are new, they will be described at an early date.

One is noticeably scorpioid in outline, due to a rapid constriction beginning at the ninth abdominal segment. At the sixth segment the abdomen measures 10 mm. across, while at the ninth it measures but half as much. The cephalothorax measures 5 mm. in length, the abdomen to the tip of the telson 23 mm., and the telson alone 13 mm. The segments seem to be destitute of ornamentations. Five appendages are exposed on one side and are distinct even to the individual joints, none of which are chelate, and there is no paddle.

Another form shows an abdomen expanding slightly to the fourth segment and then contracting and graduating insensibly into the pointed telson. The eyes and markings of the cephalothorax differ from the first-mentioned form. The abdominal segments are plainly ornamented by numerous and relatively large rounded prominences.

In a third form, noticeably vermiform, the slender abdomen tapers from the head shield to the telson. The cephalothorax is ornamented by two long and relatively broad genal spines which sweep backward to the telson. Ornamentation seems to be wanting on the segments. One distinct paddle is exposed. This small collection of seven Eurypterids was made under difficulties. Later in the season an unstable overhanging block of sandstone will be blasted away and at once several square yards of Eurypterid shales can be safely exposed. The expectation is that a considerable collection will be secured, which when properly studied will be figured and described in a forthcoming number of the Nebraska Geological Survey.

This set of Eurypterids belongs to the collections of Hon. Charles H. Morrill, who for so many years has been a liberal patron of geological and paleontological research in Nebraska.

Erwin H. Barbour
The University of Nebraska,
August, 1912

SOME NECESSARY CHANGES IN CEPHALOPOD NOMENCLATURE

While recently engaged in unraveling the somewhat tangled synonymy of certain cephalopod mollusks, the writer has noted several usages which are thought to be contrary to accepted custom. It is the purpose of this note to bring these items to the attention of other investigators and thus perhaps avoid further confusion in the future.

The genus *Desmoteuthis* of Verrill (1881, p. 300) has long been used for a group of cranchiiform squids characterized by their elongate, transparent, weakly pigmented body, oval or elongate fins, and swollen, unstalked eyes. Although an apparently well-established genus, a careful inquiry shows the nomenclature to be very involved and necessitates a change in the prevailing terminology. Verrill's genus when first advanced was monotypic and established to contain a member of the former genus *Taonius* Steenstrup, which he identified as *T. hyperboreus* Steenstrup. According to Verrill's interpretation this would then result in the following arrangement.

Taonius Steenstrup, 1861. Type *Loligo pavo* Lesueur, 1821. Additional species *Leachia hyperborea* Steenstrup, 1856.

Desmoteuthis Verrill, Feb., 1881. Type *Taonius hyperboreus* Steenstrup. Additional species *Desmoteuthis tenera* Verrill, Dec., 1881.

So far well and good, but at the next step a complication appears, for we then find that *Desmoteuthis hyperboreus* "Steenstrup" Verrill is not the same as *Taonius hyperboreus* Steenstrup, being identical in fact (or so regarded by almost all subsequent authors) with the true *Taonius pavo.* Indeed the diagnosis originally given for *Desmoteuthis* does not fit a single one of the various species now referred to it, although it does very well for *T. pavo*. Since it would certainly appear that Verrill's own definition of his type species should have weight in this connection rather than the mistaken name which he applied to it, it follows that *Loligo pavo* Lesueur is occupying the incongruous rôle of serving as the type for two genera at the same time. The inevitable result is that *Desmoteuthis* must be regarded as absolutely synonymous with *Taonius*.

It is interesting to observe that the true *T. hyperboreus* Steenstrup appears to have been subsequently described by Verrill as *D. tenera* n. sp., so that, as indicated by the above table, his concept of *Desmoteuthis* coincides most curiously with Steenstrup's idea of *Taonius*. Thus we arrive, though through a considerably different process of reasoning at essentially the same conclusion attained by Hoyle in 1884, for some reason apparently abandoned by him since that time.

What, then, is to become of *T. hyperboreus* Steenstrup, especially since according to our modern notions that species appears in no way congeneric with *T. pavo?* Fortunately it is not necessary to add another new name to the literature, for by turning to the more lately described members of the group we learn that we may utilize the *Megalocranchia* of Pfeffer (1884, p. 24) with *M. maxima* Pfeffer as the type.

Chun (1910, pp. 302, 357) has further suggested that *Helicocranchia* Massy (1907, p. 382) may also be referable to *Desmoteuthis* (*i. e., Megalocranchia*) as a synonym, but for the present I do not think this can be taken as conclusive. The minute, separated, pedunculate fins, and more especially Miss Massy's subsequent emendation "Eyes on short stalks" (1909, p. 34), along with other characters are shared by an undescribed form obtained by the U. S. Fisheries steamer *Albatross* in the Hawaiian Islands, which certainly does not seem to be a *Megalocranchia*, but much nearer to the group *Teuthowenia* as defined by Chun.

In this connection it may be well to observe that the curious Hawaiian squid described by me in 1909 as *Helicocranchia fisheri* is certainly out of place in that genus. On the contrary it appears to be a typical *Megalocranchia* having considerable affinity with *M. maxima*. The recently described *Desmoteuthis pellucida* Chun, 1910, is also exceedingly close. A brief memorandum of the several species which seem to be referable to this genus is given below.

MEGALOCRANCHIA Pfeffer, 1884

Desmoteuthis auctt., non Verrill

Megalocranchia Pfeffer, 1884, p. 24

M. hyperborea (Steenstrup, 1856).

Leachia hyperborea Steenstrup, 1856, p. 200.
Taonius hyperboreus Steenstrup, 1861, p. 83.
Desmoteuthis tenera Verrill, 1881, p. 412, Pl. LV., Fig. 2; Pl. LVI., Fig. 3.
Taonius hyperboreus Hoyle, 1885, p. 321.
Taonius hyperboreus Hoyle, 1886, p. 191, Pl. XXXII., Fig. 12; Pl. XXXIII., Figs. 1–11.
Desmoteuthis hyperborea Pfeffer, 1908, p. 104, Fig. 119.
Desmoteuthis hyperboreus Hoyle, 1909, p. 277.

North Atlantic.

M. maxima Pfeffer, 1884.

Megalocranchia maxima Pfeffer, 1884, p. 24, Fig. 32, 32*a*.

Cape of Good Hope.

M. abyssicola (Goodrich, 1896).

Taonius abyssicola Goodrich, 1896, p. 17, Pl. V., Figs. 72–80.
Desmoteuthis abyssicola Pfeffer, 1900, pp. 191, 192.

Laccadive Sea.

M. fisheri (Berry, 1909).

Helicocranchia fisheri Berry, 1909, p. 417.
Xenoteuthis fisheri Berry, 1909, p. 419 (*error*).

Hawaiian Islands.

M. pellucida (Chun, 1910).

Desmoteuthis pellucida Chun, 1910, p. 357, Pl. LIII., Fig. 1; Pl. LIV., Figs. 1–17.

South Atlantic.

The family *Veranyidæ* has recently been founded by Chun (1910, p. 139) for the reception of that bizarre little genus, the *Octo-*

poteuthis of Rüppell (= *Verania* Krohn), which with its single species, *O. sicula* Rüppell, thus becomes the type and sole member of the new family. As on general grounds this step seems one of excellent expediency, it is not a happy task to mention that the name proposed is untenable. Krohn's *Verania* appears to have been advanced solely on the ground that *Octopodoteuthis* is a misnomer since tentacles (*i. e.*, "ten feet") are actually present except in the adult stage! At any rate *Verania* is an exact synonym of *Octopoteuthis*, and hence by the International Rules the use of its derivatives in the formation of higher groups is forbidden. The family name *Octopoteuthidæ* or perhaps *Octopodoteuthidæ*, depending upon whether we reject or accept Krohn's emendation, must therefore replace *Veranyidæ* in the sense proposed by Chun.

Similar effects of the application of the same rule are seen in the case of two other families dealt with in beautiful detail by Chun. As stated by him (1910, p. 185) the genus *Bathyteuthis* Hoyle, May, 1885 (p. 272), is apparently antedated by *Benthoteuthis* Verrill, April, 1885 (p. 401), the annotated dates of Verrill's paper having seemingly escaped the observation of Hoyle (*cf.* 1886, p. 167; 1910, p. 408). If this be so, the family name *Bathyteuthidæ* Pfeffer (1900, pp. 152, 171) must lapse and the term *Benthoteuthidæ* be substituted.

At the time of publishing my preliminary report on the *Albatross* Hawaiian Cephalopods, I had not seen a really characteristic description and figure of *Heteroteuthis dispar* (Rüppell) Gray, 1849. Since then I have had access to various additional publications and have come to the conclusion that my *Stephanoteuthis hawaiiensis* is quite likely congeneric with it. The latter genus should therefore be dropped as an unnecessary synonym.

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S. S. Berry

Stanford University

SOCIETIES AND ACADEMIES

THE ANTHROPOLOGICAL SOCIETY OF WASHINGTON

The 462d regular meeting of the Anthropological Society of Washington, D. C., was held in the New Museum Building, Washington, on October 15, 1912.

Major Sylvester, superintendent of police for the District of Columbia, read a very interesting practical paper concerning criminal characteristics. It began with a brief review of the history of crime and the succession of different kinds of crimes prevalent at different periods, beginning with the cruder, such as homicide and tending toward the subtler, so that quite recently the green goods man has become less conspicuous than the forger and embezzler. The general government, it continued, has been urged to establish a national bureau of criminal identification, but such cooperative work has been left to the heads of American police departments.

It pointed out the practical difficulties of establishing a standard of the normal human being, and the imperfection of our distinction of criminals therefrom, since the police tests are applied only to those who have broken the law and many are non-criminal simply from lack of occasion. Also, we are learning that many cases of apparent criminality are only cases of mental defect or disease.

The popular impression of the criminal as a hungry, shifty individual is erroneous. The average man who makes crime a business in large cities is a fairly prosperous individual, with no fear of arrest. Some of the anatomical characteristics which Lombroso thought decisive of criminality are common in the lower races of man, whether criminal or not. Measurements in general would give racial characteristics rather than criminal.

A number of criminals charged with murder were compared in detail, with the result of showing many varieties of human appearance bracketed together.

Some special kinds of crime call for peculiarities of appearance and develop them, but with these exceptions the criminal does not usually have a different aspect from that of other people, though both criminal and non-criminal of the police classification differ among themselves. Stress was laid on conditions as largely determining the category to which a man would belong.

The paper was discussed by Drs. Hrdlička, Frank Baker, Hough, Glueck and others. The former two gentlemen chiefly emphasized the unreliability of external peculiarities relied on by Lombroso and of every sort of test which has been devised for general distinctions. Dr. Hrdlička insisted that crime is a matter of the nerves and brain or the mentality and criminal characteristics may be more due to organs and parts which are hidden than to the obvious and chiefly irrelevant external ones which Lombroso depended upon for his diagnosis. Dr. Hough chiefly explained tattooing as devoid of significance in primitive conditions, but in civilization a survival ordinarily indicating some weakness which might predispose to crime. Dr. Glueck stated his practical experience in charge of the criminal branch of the Government Hospital for the Insane and the necessity which was felt of learning all about a man's past and conditions and his behavior at every stage of his life rather than trusting to his behavior or condition at the time of any one act as a proof of criminality.

Major Sylvester condemned the evil influence of politics in preventing the police of some large cities from bringing criminals to justice.

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CONTENTS

MSS. intended for publication and books, etc., intended for review should be sent to the Editor of Science, Garrison-on-Hudson, N. Y.

THE NEED OF PRACTICAL COOPERATION OF EDUCATIONAL AND OF MEDICAL DEPARTMENTS IN MODERN UNIVERSITIES

The object of this paper is, first, to show the present status of affiliation of schools or departments engaged respectively in the training of physicians and of teachers, and secondly, to present a plea for a more general and effective cooperation between medical and educational departments where the interchange is warranted by technical training and material resources in both departments. Herein we are concerned particularly with the training of teachers pursuing at least a four years' course in a good college or university department of education and also, on the medical side, with the supplementing of the training of prospective physicians who intend to participate in the work of the schools.

Our general topic suggests the whole field of modern sanitation as it concerns not only the teacher and the medical inspector, but also the engineer, economist, etc., a field into which more than one of our universities have entered. We shall consider only hygiene and related topics as mainly affecting the teacher, superintendent, principal and the medical inspector, school nurse and assistants.

The actual status of the affiliation between medical and pedagogical departments of universities in the United States is revealed in the results of inquiry instituted by the writer in March, 1912. A circular of inquiry, including stamped return envelope, sent through the Newcomb School of Education, was mailed to the deans respectively of every medical department or college and of every educational department in the United States, according to the enumeration in the U. S. Educational Report. Homeopathic, eclectic, physio-medical colleges, etc., were omitted.

H. Sophie Newcomb Memorial College
The Tulane University of Louisiana
New Orleans
March 7, 1912

Dear Sir:

I am attempting to obtain definite information concerning the present affiliation of the medical and the pedagogical departments of typical American universities. Will you kindly cooperate to this end by responding to the following questions and return this sheet in the enclosed envelope?

I. (*a*) What courses intended specifically for teachers or prospective teachers (elementary, high, normal school or college teachers and principals or superintendents) are being offered by your medical department? (*b*) Duration of courses? (*c*) Number enrolled this year? (*d*) Any certificate or diploma awarded for completion of same by teachers or prospective teachers?

II. (*a*) What courses in pedagogy are offered by your department of pedagogy or education for the benefit of physicians or medical students or nurses who are or intend to become inspectors of schools? (*b*) Duration of courses? (*c*) Number enrolled this year? (*d*) Any certificate or diploma awarded for completion of same by physicians, medical students or nurses?

III. Please write any other relevant information or practical suggestion regarding possible need for cooperation between medical and pedagogical departments.

Yours very truly,
David Spence Hill

To the medical colleges 112 inquiries were sent out, and to date 69 responses have been received. To departments and schools of education 102 responses are at hand from 160 inquiries—many of them sent in both instances to very small institutions.

The responses may be generalized into the following groups:

1. Those from medical colleges which have no university connections and which report no work whatever for the benefit of prospective teachers.

2. Responses from educational departments within colleges and universities which have no medical departments and which offer no work especially intended for medical inspectors, school nurses or school sanitarians.

3. No active affiliation reported from medical and from educational departments of certain universities.

4. Active or pending affiliations and cooperative courses in medical and educational departments, where prospective teachers with adequate academic and professional training and prospective physicians hold common interests.

5. Individual opinions and suggestions concerning the need of such affiliated courses.

Most of the responses are of types 1, 2 and 3. It is evident that so far as formal action by our institutions of learning is a criterion, the training of the majority of physicians and teachers in colleges is not parallel or merged and generally there is no point of practical contact. In view of the Carnegie report on medical education, and in view of the struggling existence of the courses of education, especially in normal schools, and to a less degree in college departments of pedagogy, this status of affiliation in some respects is satisfactory, although the correlated facts are deplorable. Scarcely a half dozen universities in the United States report a reasonably effective scheme for cooperation of medical and of educational departments. In view of the needs about to be enumerated and of a growing conviction that teachers need more scientific knowledge of hygiene in its broader sense, more knowledge both of mental processes and of the physiology of the child, as well as of the subject to be taught, and that physicians who are medical inspectors are often lacking in adaptability, understanding and are actually incompetent without a sound basis of educational science—this failure of the prospective teacher and the prospective doctor to get together is unfortunate for both and for the child. Furthermore, there is a growing suspicion that one of the factors in the low state of medical education is the poor teaching done within the walls of medical colleges and the poorer grasp of the complex problems of the education of to-day. This is a day, in America and Europe, for the professional training of teachers; but who has heard of systematic provision for training teachers of medical students?

Nearly all of the small number of responses of groups 4 and 5 may be reproduced here verbatim, with a few of other types. As these responses are generally from representative institutions they constitute an interesting symposium. A few responses which came unsigned are omitted. A later mail may bring in also a few more. Here are the responses from the following institutions in slightly abbreviated form and with the name of the senders prefixed: Johns Hopkins, Pennsylvania, Chicago, Teachers College of Columbia University, University of Pittsburgh, University of Cincinnati, St. Louis University School of Medicine, the University of Minnesota, the University of Wisconsin, the State University of Iowa, the University of Illinois, the University of Nebraska, the University of Michigan, the George Washington University, Vanderbilt University, University of Virginia, the Tulane University of Louisiana.

Johns Hopkins University, Baltimore, Md. Dean J. W. Williams, Medical Department.

Your circular concerning the affiliation of medical and pedagogical departments of American universities is at hand. Our medical school makes no effort to give this sort of instruction. The philosophical department of the university, however, offers a number of courses to teachers and in its summer school affords opportunity for instruction. Furthermore, a number of "health courses" are offered to the general public by the medical and chirurgical faculty of Maryland (The State Medical Association).

Professor E. F. Buchner, Department of Education and Philosophy.

I regret to state that we have nothing to report from the Johns Hopkins University on the cooperation between the medical department and the various lines of work which are being offered to teachers. For one reason at least the need of this cooperation in Baltimore is not so essential, in view of the fact that the medical and chirurgical faculty in addition to the several medical schools and medical associations, has been doing a great deal of work along the line of the medical aspects of public education.

University of Pennsylvania, Philadelphia, Pa. Director A. C. Abbott, of the Laboratory of Hygiene.

I have read the several questions contained in your letter, and do not feel in a position to give categorical answers to any or all of them, although one of the courses given in this laboratory might be regarded as remotely related to the topic which you are considering. The course to which I allude is that leading to the degree in public hygiene, a subject that has been sadly neglected in this country, and one for which trained teachers are more or less in demand. I can not say, however, that the course is designed especially for the training of teachers, but rather with the idea of giving to the candidate a broad grasp of the fundamentals of the subject in such a manner that they may be used for either teaching or practical work in the field of public hygiene. There is one portion of the course, I think, which might properly be regarded as suitable to teachers in any department, notably, that having to do with the various defects observable in school children. It is the portion of the course designated as medical inspection of school children.

Harvard University, Cambridge, Mass. Dean Henry Christian, Dean of Medical College; Professor Henry W. Holmes, Division of Education.

No affiliation of the Medical and Pedagogical Departments of this university.

The University of Chicago, Chicago, Ill. Dean John M. Dodson, The Medical Courses.

There are no courses specially designed for teachers or prospective teachers in the biological sciences department where the medical courses are taught. Many teachers, however, take some of these courses each year, how many it is not possible to say accurately.

I am mailing to your address an announcement of Rush Medical College, in which you will find all the courses described. I would say that a few teachers expecting to go into physical-culture work take the courses in human anatomy. Others do work in physiology, pathology and bacteriology. No certificate or diploma is given to students completing these courses. They may be taken by students registered in various departments of the University of Chicago and allowed to count for credit towards the bachelor's degree.

We hope that the several departments in the university will offer courses relating to hygiene and sanitation and that we may be able to offer a definite curriculum designed for men and women who desire to go into the public health service. At present no such courses are offered.

Chicago University, Chicago. Ill. Director Charles H. Judd, the School of Education.

There is no active affiliation between the college of education and the medical school. One of the members of our faculty is finishing his work in a medical course in Munich, Germany, during the present year, and expects to take up work for retarded children with the opening of school for next year. This work will be done, however, in the college of education and not in the medical school. I think some such affiliation as you have in mind would be of very great advantage, but we do not have it as a matter of fact at the present time.

Teachers College, Columbia University, N. Y. Dean James E. Russell.

We have no connection with the school of medicine. However, the professor of physiological chemistry directs our work in that line. We have large departments of our own in hygiene, nursing and health, etc. Please see announcement sent herewith.

The University of Pittsburgh, Pittsburgh, Pa. Professor W. G. Chambers, the School of Education.

None in medical department. Certain teachers in the city schools have taken courses in physiology, bacteriology and the like with the regular medical classes. Plans are now being developed looking to a cooperation of courses between the school of medicine, the school of education and the college. In the school of education our courses, psychology and principles of education, school hygiene, psychology and pedagogy and defective children and the like, are open to medical students, but have not been attended by any to date. We are planning to offer a course for the training of school nurses which will include work in both the medical school and the school of education. We are now about to start a group of clinics, involving a psychological clinic, a social clinic, a medical clinic and a dental clinic, which will bring together the four corresponding schools of the university in a work which affects the training of teachers. A certificate will be granted for the work mentioned.

University of Cincinnati, Cincinnati, Ohio. Dean W. P. Burris, College for Teachers.

We have no such affiliation between the medical and pedagogical departments as you imply. I have often thought about the question of relating these departments, but could not decide how it could be brought about. I will be much pleased to learn the result of your inquiry. I have no doubt that teachers and instructors would profit greatly by some correlation of medical and pedagogical courses.

St. Louis University School of Medicine, St. Louis, Mo. Dean E. P. Lyon.

Your circular letter regarding the teaching of pedagogics in St. Louis University came to the medical school. As we have no such work in this department, I am referring the letter to the college department in which young men are trained for teaching in the Jesuit order. I have no doubt you will hear from the authorities in regard to this work. In writing you, I am reminded of a thought which has frequently recurred to me, namely, there is no normal or teachers' college for medical teachers. I believe that medical teaching has need of application of pedagogical principles. It is possible that people who are specifically engaged in the work of teachers' colleges might be of some assistance to medical education by studying these questions.

The University of Minnesota, Minneapolis, Minn. Dean F. F. Wesbrook, College of Medicine and Surgery.

We shall have to answer most of your questions in the negative, but we desire you to know that we have thoroughly considered and are planning for the various phases of public health instruction. In answer to your question number 1, we have to say that certain of the teachers on the staff of this college are giving instruction to students in the college of education—notably Dr. R. O. Beard, on personal hygiene. I myself give instruction in the matter of infectious diseases and their prevention and have every year for some years tried to give practical talks along these lines. We are, however, giving no courses in the college of medicine and surgery as such, which are intended for students in the college of education. All of the students in the college of education attend the instruction by Dr. Beard and myself. No definite courses in pedagogy are offered to the students in our college, but you will see in the catalogue of the current year, pages 58 *et seq.* We provide a coordinated series of lectures by those who are well able to give the work. For instance, Dr. Keene, who is in charge of the physical training and medical school-inspection of the Minneapolis public schools, instructs our students in medical school inspection, physical training and school hygiene. Mr. Rankin, professor of education in our university, and Mr. C. G. Schulz, state superintendent of public instruction, and *ex-officio* a member of our board of regents, both give instruction to our medical students in their senior year in this course of which I have spoken; one from the view-point of the teacher and the other from the point of view of the child. In this way we get a symposium by those whose daily work is giving them practical experience in the lines which we ask them to teach our students. We have similar symposia on the tuberculosis question. I enclose herewith copy of that which was given this year. The same sort of thing is done in the matter of milk supply, its sanitary aspects, etc. At the present time I have been instructed by the board of regents to report upon a public-health school here in our university and expect to report a definite mechanism within the next short time.

Dean George F. James, College of Education.

We have not yet worked out a plan of cooperation between our medical college and the college of education, although we are interchanging some lectures at the present time. Some of the medical faculty have been assisting in our work in school hygiene and some of our men have been speaking occasionally to the medical students on conditions which seemed helpful for them to know in regard to the schools.

The University of Wisconsin, Madison, Wis. Dean M. V. O'Shea, Department of Education.

In this department none whatever, although I earnestly hope such courses may be offered within the next two or three years.

Dean Charles R. Bardeen, Department of Pharmacology and Toxicology.

In the department of physiology a special course is offered for prospective teachers of that subject in high schools, normal schools or colleges. In the department of anatomy a special course is offered for students preparing for teaching physical training. In the department of bacteriology and hygiene courses are offered in these subjects open to teachers. In the other departments of the medical school no specific teachers' courses are offered, although occasionally special training is given individuals who may desire to teach. So far as I know, no courses are offered in the department of pedagogy for the benefit of physicians or medical students, or nurses who are or intend to become inspectors of schools. Many of our medical students do some teaching after completing the two years of the medical work which we offer before going elsewhere to complete their medical course. All such prospective teachers, if they intend teaching in Wisconsin, have to take some courses in the departments of education on the principles of pedagogy. In general I should say that public school teachers should have more acquaintance with preventive medicine than most of them have at present, and that we should probably look forward here to developing special training of this character, although little is done at present. I shall be glad to hear the results of your inquiries in order that we may have data from which to derive methods along these lines. I feel that we have at the University of Wisconsin, at the present time, little along these lines which would be of value to you.

The State University of Iowa, Iowa City, Iowa. Director Frederick C. Bolton, the School of Education.

I regret very much that we have no satisfactory data to report concerning the relation between the college of medicine and the department of education. There is an entirely cordial feeling existing between the faculty in the medical college and the department of education. Several of the faculty members are much interested in our work in education, and we are certainly interested in many phases of their work. There is a movement on foot to establish a psychopathic hospital, the activities of which will include some phase of educational work. It will include the training of defective children. Some of the members of the faculty of the college of medicine are directly interested in the pedagogical side of the work. It may be that at a later time I can write you additional information concerning our work. I believe there ought to be a definite relation and there ought to be a pedagogical training for those who are preparing to be school physicians, on the one hand, and, on the other hand, the regular teachers ought to get some knowledge of psychopathic conditions.

The University of Illinois, Urbana, Ill. Dean William E. Quine, College of Medicine.

Reports "none" for the questions.

The University of Nebraska, Lincoln, Nebr. Acting Dean Robert H. Wolcott, College of Medicine.

Cooperation between the pedagogical department of the university and the medical school is a thing very much to be desired. We have discussed the matter here somewhat and a certain amount of cooperation has been effected by the formation of a section on public health in the State Teachers' Association, the activity of which is largely the activity of the college of medicine, and also by the giving of occasional lectures in the course of pedagogy by those connected with the faculty of the college of medicine. A condition which has interfered somewhat with close cooperation is the fact that our medical school is divided, the two clinical years, including the courses in sanitation and hygiene, being given in Omaha, and the first two years consisting entirely of laboratory work, being given here. Not only are the members of the faculty here in Lincoln engaged in teaching subjects not particularly important to the students in pedagogy, but the work already required of them is so heavy that I do not feel it fair to impose an additional course upon them.

The University of Michigan, Ann Arbor, Mich. Dean V. C. Vaughan, Medical Department.

A course in general hygiene given in the medical department of this university is open to all students in the literary department, and is especially recommended for those who intend to teach. Every student entering the university should have a thorough physical examination, and it would be better if this examination could be repeated once a semester. In all departments of the University of Michigan except the law department, all entering students are compelled to take a thorough physical examination. Any defects are referred to the physicians in the medical department. Students in the medical department are required to pass a physical examination once a semester.

The George Washington University, Washington, D. C. Dean Bowden, Department of Medicine.

We have no courses in the department of medicine of this university intended especially for teachers or prospective teachers. There is a teachers' college which is a department of the university in which instruction is especially given to teachers and some of these students take courses in physiology and histology in our laboratories. Up to the present time the above method, namely, of having students in the teachers' college taking such courses as they desire in our medical school appears to have covered all requirements.

Vanderbilt University, Nashville, Tenn. Dean Dudley, Medical Department.

No educational department.

University of Virginia, Charlottesville, Va. Dean Whitehead, the Medical Department.

No such courses offered by this department.

University of Texas, Austin, Texas. Dean W. S. Sutton, Department of Education.

None, but in the course in school management and also in a course of school administration and supervision some attention is given to matters relating to school hygiene. In the further expansion of the department of education in the University of Texas it is hoped that provision will be made for the establishment and maintenance of a school of physical education, in which school a number of courses will be conducted.

Leland Stanford Junior University. Executive Head R. L. Miller, Department of Medicine, San Francisco, Cal.

The courses for medical students in physiology, anatomy, chemistry, bacteriology and embryology are all given immediately at the university. Many students from the educational department take them and all can do so if they have proper preliminary work. Certificates or diplomas are awarded only as parts of the work leading to the university degrees. In the educational department about 30 students take course 28, physical aspect of the child (Professor Terman); and about 50 take course 29, school hygiene (Professor Terman). A few of these will later complete a medical course and take up school hygiene as a profession.

The Tulane University of Louisiana, New Orleans, La. Dean Dyer, Medical Department.

None at present. Projected courses for teachers and prospective teachers in department of hygiene and preventive medicine.

Professor Hill, Psychology and Education.

Arrangements are nearly completed whereby candidates for the B.A. degree in education, prospective teachers, may elect hygiene for their major subject. The work in hygiene will be partly under the direction of Professor Creighton Wellman, of the school of tropical medicine and hygiene. The administrators also have made an appropriation for a laboratory of psychology for Newcomb College, an adjunct of which will be a psychological clinic for the study of the problems of childhood. In this work members of the medical staff, it is intended, will cooperate with psychologist, teacher and sociologist. The work of the laboratory begins in 1912.

The reasons for the advocacy of a more effective cooperation of physicians and teachers within such departments may now appear from consideration of several aspects of the subject. The basis of modern teaching is experimental and genetic psychology. The need of contact between physician and teacher in the study of scientific psychology is recognized in the problem of psychopathic conditions of childhood. Dr. J. E. Wallace Wallin in a recent number of the *Journal of Educational Psychology* has summarized the data concerning the growth of clinics for the study of psychopathic conditions in school children. In these educational laboratories psychologists, physicians and educators unite in studying the problems of the exceptional child whose unprovided for presence in our schools is to-day potent in affecting the lives of the majority of the pupils and the teacher. Notable among such institutions are Professor Goddard's laboratory at Vineland, N. J., Professor Witmer's clinic at the University of Pennsylvania, Dr. Healy's in Chicago and the Psychological Clinic conducted by the Gatzert Foundation for Child Welfare of the University of Washington, as well as others existing or projected. The recent discussion participated in by Myer, Watson and others in Washington during the meeting of the American Association for the Advancement of Science concerning the relation of the psychology of the academic department to the work of the medical schools, evinces this issue before the medical college, an issue which concerns both pedagogy and medicine. The unity of mutual interests in the field of pedagogy is pressing both upon the educator and upon the physician.

There is the increasing recognition by our citizenship of the importance of the physical aspects of life in the process of education. This modern recognition of the physical correlate of psychic life is evinced by many signs. There are the concerted efforts of legislators, reformers, physicians and educators in behalf of better sanitation of the schools. There are movements for improved medical inspection of children, teachers and premises, for accumulative records concerning physical and mental development and for study of, and providing for, the detection and care of, feeble-minded children. Organizations such as medical associations, educational associations and civic societies have united in their efforts in behalf of the health of the child, since the larger meaning of health in its relation to formal education has become better understood. It is significant, for example, that we read of the cooperative efforts of physicians and of educational specialists in the report of the Public Health Educational Committee of the American Medical Association as published in the Proceedings of the National Education Association. Equally significant as a symptom is the report of the sub-committee of the Committee of One Hundred of American Medical Association which recommends for medical education, in behalf of public sanitation, practical means for actual cooperation of physicians, lawyers, engineers, statisticians, professional sanitarians and educators. With regard to the last the recommendations embody the following: "The medical point of view should be given to the educationalists and the medical man should add to his medical knowledge some practical working experience in the daily problems which confront the educator."

The increasing literature both from students of education and also of medicine concerning the health of the school child, and the discussions by both teachers and by physicians at international and at local congresses of school hygiene also are evidences of the world-wide significance of the theme. Researches upon specific activities of school life as affecting the human organism, in both its physical and psychical aspects, are further evidence of the advent of the method of science into the realm of pedagogy. Contrast, for example, the obsolescent pedagogy of opinion *vs.* fact, of metaphysics *vs.* statistical investigation, with such recent quantitative investigations as those of Meumann, Winch, Thorndike, Dearborn and Ayres. If in the past educators have been addicted to metaphysics and the didactic habit, equally physicians have been alleged to lack any "quantitative sense." The present trend in literature toward exact observation is bringing both professions closer.

The remarkable growth of medical inspection of school children is due to the wide recognition of the necessity of cooperation between teacher and physician. At the basis of this cooperation is the modern belief that health, wholeness of body and mind, is the prerequisite of maximum good for the individual and for society in education. Most of us have reacted far from the ideal of Stylites who considered that superlative moral excellence was best gained through indifference and even torture of the body:

> . . . I die here
> To-day, and whole years long, a life of death,
> Bear witness, if I could have found a way—
> And heedfully I sifted all my thought—
> More slowly painful to subdue this home,
> Of sin, my flesh, which I despise and hate
> I had not stinted practise, O my God!

The practical interdependence of body and mind is evident enough whether we chose evidence from: the facts (1) of common experience, (2) of pathology or from (3) the psychological laboratory. But in the past many, and in the present not a few, educational leaders seem to neglect this significant fact. They have busied themselves with the subtleties of metaphysical speculation to explain the ultimate nature of this mind-body relation, or failed altogether to profit by the opportunity for, and the results of, research, regardless of the ultimate nature of reality. Whether as physician one is interested predominately with the physical aspect of the human organism, or whether as teacher predominately with the mental aspect, neither skilled teacher nor physician today can ignore the physical or the mental to the neglect of the other. So far as both teacher and physician are men and humanitarians, each is willing to supplement the other where cooperation facilitates the progress of the race. Notwithstanding the endless differences of opinion about the details of educational theory, and the rumor that in their respective councils both doctors and pedagogues disagree, nevertheless one sure point of agreement in education is the necessity for adequate provisions for health, both in school and in industry. The health movement in education is one of the most hopeful signs of the times; it is based upon the logical results of experience and of systematic observation and has more far-reaching results than the results merely within the school room. It is a beneficent influence that is modifying architecture, sewerage systems, food supply, methods of control and prevention of disease, and is modifying our art, our ethics and our religion, man's three great remedies for the evils of human knowledge. Opposed we find the horde of the "curists," whether simply ignorant or neurotic or criminal.

The cooperation of trained workers in the medico-pedagogical field has gained headway against difficulties. Inertia of public opinion, administrative difficulties and organized opposition from combinations of quacks, enthusiasts and patent-medicine interests opposed to state control of health measures, are difficulties encountered in many states. One of the most vicious combinations of heterogeneous frauds is the American Association for Medical Freedom, which through paid representatives has been perniciously active in efforts with legislative assemblies, as, for example, recently in Tennessee.

Difficulties of another kind are: (1) incompetent and unintelligent physicians in the public-school services; (2) incompetent and unintelligent teachers; (3) the resulting failure to obtain the desired cooperation of a scientific pedagogy and of scientific medicine in behalf of the school child. The incompetency of the school physician, if we take for granted his moral worth, may be with regard to training either in medicine or in pedagogy. The Flexner and other reports are proofs regarding the low condition of medical education in America. It is difficult throughout the country to secure highly skilled physicians to do the unremunerative work of school inspection. This notorious difficulty increases the want of respect that the teacher and citizen have for some medical inspectors, school physicians and sanitarians. The deficiency of the average physician in pedagogy, or in the science and art of education, is not unexpected, but his frequent lack of appreciation of the inherent complexity of the problems of the school or of knowledge of any one large part of modern pedagogy, be it educational psychology, experimental pedagogy, the history of education, the principles of education, educational statistics and quantitative treatment of data, lessens both his working efficiency and the respect and influence which his work should bring. If we couple with this two-fold incompetency an air of wisdom and the trick of silence in the medical inspector, it then results that he gains the contempt of the men and women in education who may have enjoyed thorough academic and professional training for their life work. Personalities being equal, the man who has his doctor of philosophy in education from a modern university following the requisite bachelor of arts in college, is relatively better trained for the work of the school than is the average physician who possesses merely the degree of doctor of medicine, for the practise of medicine. Very few young physicians of to-day, relatively to the number being graduated, have collegiate training, or prolonged experience within schoolrooms, and, if literary degrees be any criterion of school experience they have less of this academic training than students in law or in theological schools. Note the recent statistics of the United States.[1]

Schools	Students	Number having Literary Degrees	Per Cent.
184 theological,	11,012	3,064	28
114 law,	19,567	4,107	21
135 medical,	21,394	1,883	9

In the majority of physicians from whom we must choose our medical inspectors and school physicians, we observe neither academic training in general culture courses nor pedagogical training, such as is being demanded more and more of every teacher for the elementary, high and normal schools and colleges. Great is the need of the presence of the physician-inspector in the public school, but great also is his need of academic knowledge and of training in the essentials of pedagogy. To the average citizen the physician comes in moments of dependence and with a traditional prestige and with at least a modicum of technical knowledge which he may wield to the disadvantage of the layman. The partially trained physician in the presence of the problems of the school, naturally may suffer from a mental myopia from which he is unconscious and it is difficult to convince him of his ignorance where it exists. The pedantry of the confirmed pedagogue may have its counterpart in the professional assurance of the routine practitioner and the common, invalid assumption that "a man skilled in one thing is good at everything he undertakes."

If we are to bring about needed cooperation in the medical and teaching professions in life we must begin with fundamentals. We should labor with the professional training of those who are to work, either as teachers or physicians, in our schools. Already the medical profession has achieved greatness in the education of the people in the prevention of disease. Through literature, lectures, committee work, legislation and public-spirited activities, the beneficial effects of the noble work of prevention of disease is felt in every path of life. Magnificent are the results of the modern physician and sanitarian in the battle, *e. g.*, against yellow fever and the hook worm, or against tuberculosis. This country of modern cities with stupendous populations could not exist happily but for the public hygiene engineered by noble spirits in the medical profession.

In the schools we have millions of our population, the majority of our people during the years of plasticity and during years when they are amenable to a high degree of control. In the schools is the superlative opportunity for teacher and

[1] U. S. Ed. Report, 1910, Vol. II., p. 1017.

physician cooperating to benefit the race. If it be agreed that both educator and physician should understand and practise school hygiene as only one of the increasingly numerous departments of a modern pedagogy, how can this knowledge and practise be affected without specific, organized training in hygiene, both for prospective teachers and prospective medical men, for the schools? Educational hygiene is but one division of the field of hygiene and demography. Consideration of its bare outlines as offered for discussion at the next international congress on hygiene and demography should yield the conviction that if this field is to be mastered, the medical and educational departments of modern universities are laggards in progress where effective cooperation is not accomplished.

In conclusion we may venture to enumerate four ways for effecting an immediate and practical cooperation between the educational and pedagogical departments of well-equipped universities.

1. With reference to the need of the schools, provisions should be made for senior medical students, and especially for graduates in the educational department, by instruction and training in the essentials of pedagogy to be chosen from courses and with books such as: "History of Education" (Monroe); "Principles of Education" (Bolton); "Educational Psychology" (Thorndike, Starch, Pyle, Bagley); "Educational Statistics" (Ayres, Thorndike); "Experimental Pedagogy" (Whipple, Meumann, Claparede). These presuppose a basal knowledge of psychology—some of which must be got in the laboratory. In this basal study of psychology of common interest to teacher and physician, the majority of medical students obtain no systematic training whatever, a fact not surprising since, according to Flexner's report, half or more of the medical schools require less than a good high school course for admission; half have meager laboratory facilities even for physiology, pharmacology or bacteriology; teaching of anatomy and pathology is often didactic; clinical facilities are usually inadequate and many colleges are "reeking with commercialism." In medical departments where such deplorable conditions do not exist it seems most reasonable to supply instruction in general or introductory psychology, both to medical and pedagogical students, by utilization of the psychological laboratory of the academic department.

Medical students who undertake the work in pedagogy as prospective school inspectors or school physicians should undertake the extra training either in a graduate year or elect a minimum during the senior year of the medical course. This election would necessitate the elimination of certain fractions of pharmacology, obstetrics or studies not of essential use to the professional school physician. This questionable elimination, however, would be avoided by placing all of the pedagogical work, save the elements of psychology and of hygiene, in the post-graduate year or years. Since the writing of this paper, some interesting detailed suggestions regarding such adjustments of curricula have been offered under the title: "Professional Training for Child Hygiene" by Professor Lewis M. Terman, Ph.D. (*Popular Science Monthly*, March, 1912).

2. Appropriate courses in education should be offered prospective school nurses.

3. In recognition of the fact that throughout the country the majority of high-school teachers lack professional training in both the subject they teach and also in pedagogy, there should be a more general effort in our universities to supply the present need for professionally trained

teachers for high schools, whenever the bachelor's course is regarded as the maximum obtainable preparation. The college student who desires to become a specialist in school hygiene or a public sanitarian may omit the regular medical course and proceed from the bachelor's degree to the doctor of philosophy in hygiene or to the new degree of doctor of public health. In order to open this field to college men and women, candidates for the bachelor of arts in education should be permitted to follow hygiene as a major subject, extending through at least three years and properly correlated with other sciences, cultural and professional courses. In the courses, hygiene, preventive medicine, physiology and psychiatry, the medical department may be utilized. The following typical plan for grouping of studies for prospective teachers in college makes possible the choice of such a major subject and at the same time affords in the four years following the high school: (1) a basis of general culture in the languages, mathematics, sciences and history; (2) the essentials of pedagogy; (3) opportunity for increasing specialization under the direction of competent advisers.

Freshman	Sophomore	Junior	Senior
Eng. 3 hrs.	Eng. 3 hrs.	Gen. & Ed. Phy. 5 hrs.	Hist. & Prin. of Education 5 hrs.
Lang. 3 hrs.	Lang. 3 hrs.	Educational Hygiene 3 hrs.	El. or Secondary Education 3 hrs.
Math. or Hist. 3 hrs.	Math. or Hist. 3 hrs.		
Phys. or Chem. 5 hrs.	Biology (Physiology) 5 hrs.		
Elective 3 hrs.	Elective 3 hrs.	Elective 9 hrs.	Elective 9 hrs.
Total 17 hrs. per week.	17 hrs.	17 hrs.	17 hrs.

The electives (major and related subjects) courses should be chosen under careful guidance and with proper restrictions.

4. In the study of the school problems of elimination, retardation, repeating and of the exceptional child, the department of education should lead. The educational laboratory, and psychological clinic, an adjunct to the laboratory of psychology, is the point for concentration of effort upon these problems, by cooperation of psychologist, physician, sociologist and teacher. The demonstrated value of the modern psychological clinic must be rescued and preserved from the errors and excesses of incapable men and women, whether in medicine or in education.

DAVID SPENCE HILL
TULANE UNIVERSITY

THE EDUCATIONAL WORK OF A GREAT MUSEUM[1]

THE educational work of a museum should be governed entirely by the purposes for which the museum is established. The very greatest museums may give pleasure to the public, may educate the more intelligent groups of people, among which are college graduates, may educate such classes as teachers and children, and should not neglect the education of the masses. One of the most important services to education which a great museum can accomplish is to carry on surveys, explorations and original investigation, and it is only from such work that any facts are learned which may in turn be given out to mankind by means of exhibits, popular guide-books, scientific reports, lectures and contributions to encyclopedias, textbooks, popular magazines and newspaper accounts. Great care should be taken that research work is never neglected in the stampede for "popularization." Such great museums may also have departments for special

[1] An abstract of an illustrated lecture delivered, in anticipation of the opening of the Victoria Memorial Museum, the national museum of Canada, at the inauguration in Ottawa of free lectures to the people under school board control, November 10, 1911.

classes of the people, as for instance blind people and kindergarten children.

Special museums must serve the specialty for which they are founded, and small museums also have to confine their work to a narrower scope of educational endeavor. Provincial museums seldom have sufficient funds to make world-wide investigations or teach all subjects, and it is perhaps best for such a museum to devote itself solely to its own province or certain subjects. The same is also true of a county, and in some cases a city, museum. The university museum should serve the purposes of the university, its students and professors, that is, supply illustrative material for classes, provide for the research necessary to keep professors up to date, and allow advanced students actual research experience. In common honesty its funds should not be used primarily for the general public or for subjects outside the line of the university's work. An art museum must confine itself to esthetics or other branches of art endeavor. A commercial museum of course should keep its attention on work of a commercial nature. It is evident that there are many methods of museum administration, each of them good in its own place and each of them bad or even dishonest when out of place.

A museum building should be constructed so that additions may be made to it without ruining its architecture or causing unnecessary expense for remodeling or making connections. Such a building should be built with a view to its purpose so that the laboratories, offices, exhibition halls and the like may be properly lighted and each suitable for its special kind of work. In the past museums have usually been built to please an architect and the result is that most museum buildings are abominably adapted to the use of the museum and its staff. The day must soon come when museum buildings will be constructed with a view to the purpose for which they are to be used and then the result of museum work will be even more worth while than at present.

No matter what the scientific investigator and the teacher may say, one of the justifiable purposes of a museum is to give recreation and happiness to great masses of the people and by far the greater number of visitors to the large museums drop in casually for just these purposes. Very few of them come to be educated or to carry on research, but from the casual visits many people carry away a desire to investigate and still more to receive educational benefits.

The educational section of a museum may be likened to extra illustrated text-books. For instance in text-books on birds, we may have pictures of birds, even colored pictures, but in a museum we have the actual birds, their skeletons, their organs, their nests and their eggs. Thus a large collection of birds in a good educational museum is like a great text-book on birds illustrated by these things, while the labels take the place of the printed matter in the text-book. Educational popularization should never be carried to the extreme of exaggeration and untruthfulness affected by certain schools of museum employees.

A museum may also serve as a great warehouse where are kept such valuable things as individuals should not horde in their homes. For instance an object from which something may be learned, and which is the only object of its kind in the world, should not be kept in a home where it may be destroyed by fire, but in a fireproof museum; nor ought it to be where its owner and his friends are the only ones able to see it, but it should be available for all who may desire benefit from it, whether they be citizens of the province or nation owning the museum, or visitors from the most distant lands. No museum should be a collection of merely curious things.

Sometimes animals, plants and the like are exhibited surrounded by representations of their natural home and in front of a painting representing the country in which they occur. Such exhibits depend for their excellence on the skill of the scientist who plans them, the collector who secures the material and artists and mechanics of various kinds. Each of these does a particular share of the work which he is perhaps the only man able to do. The artist may be brought thousands of miles because of his ability to paint just the right kind of background. The museum expert is skillful in writing labels which may be understood not only by the scientist, who often knows all the facts without any label, but also by the people who do not know the facts and consequently need information. Such a man should write the label.

In a great research museum there are always thousands of specimens in the storerooms and laboratories kept for study and research; that is, they are used for the increase of human knowledge. To expose them to the light and dust of exhibition might destroy them while duplicate specimens, pictures, casts and models may serve equally well or even better for educating the public.

All great museums have brains, in other words they have a staff of experts who perhaps are not seen in the exhibition halls, but who find out the new knowledge which the people are always anxious to have, who plan the work, write the labels and guide-books, give the lectures, direct the field explorations and so keep the museum from ever being dead and dusty. One of the great museum men of the world once said that a finished museum was a dead museum, and this well expresses the idea that there is no such thing as a finished museum, for scientists are always making new discoveries which lead them to add new exhibits and rearrange old ones. There is always a great deal of work going on in the workshops, of which the visitors to the exhibition halls have little idea. This work can not be done by untrained men, but must be accomplished by artisans, mechanics and artists who have had very special training each in his own particular line. Sometimes in a country of millions of inhabitants there is no man trained in a certain special kind of work so that a museum often has to send across the sea or to some equally far-away place for a skilled mechanic. Even Japanese, Eskimos and Indians are employed in one of our largest museums. Many days' and sometimes months' work must be done—not by one man but by seven or eight men, each doing his own kind of work in the most expert way—to produce an exhibit from which the public may learn in a few moments what has taken all this time to produce. Then too one must not forget that to get some material by means of which new knowledge is found out, and by means of which this knowledge is diffused to all the world, hardy men must penetrate into the uttermost wilds of the earth, endure the bitter cold of the Arctic and the dangers of the tropical forest.

Some museums have many friends, for instance for years the Barnum and Bailey circus had all of its rare animals which died on the road embalmed or otherwise preserved and sent to one of the museums in New York City. Then, too, wealthy men vie with each other in giving funds for expeditions, research, scientific books, exhibits, teaching labels and guide-books, and for lecture courses in connection with these museums. Sometimes they endow a branch of museum work or an entire museum. Some men have each given more than a million dollars for such purposes and this is one of the indications of the value of a museum, for men capable of amassing millions do not endow institutions which they consider valueless.

Sometimes models teach quite as much as actual specimens. A model of a mosquito made many times larger than the insect itself shows us how to cope with malarial fever and yellow fever. We could not see the means by which the mosquito transmitted these diseases by looking at the mosquito herself, but the scientist in his laboratory with his microscope may find out all these things, make accurate plans and drawings of the various parts of the insect, and leave it to skilled mechanics to spend many months in reproducing them accurately on a large scale. Such work is not an extravagance when we consider that if the doctors and the people learn to avoid yellow fever and malaria the life insurance companies do not have to pay so much life insurance and the amount paid for one death is easily sufficient for the construction of such a model.

Pictures are very useful in connection with museum exhibits. Sometimes photographs are used, again sketches or paintings or transparencies, and frequently lantern slides are employed. These pictures may show the sort of country from which the objects come, or they may be reconstructions based on careful study. For instance, bones of extinct animals are frequently found. No one knows what these animals looked like in life, but the scientist can study the bones and compare them with the bones of animals which he is able to observe. He can have his artist paint these living animals and can explain to him in what respect the bones of the extinct animal differ. By a study of the bones of the feet he may learn and explain to the artist whether the animal walked in a swamp or on rocky ground. By a study of the animal's teeth he may tell what kind of food it ate. Then the artist can make his picture very much more intelligently than otherwise would be the case and this picture conveys to the people some idea of what the animal formerly looked like. Sometimes the artist makes a sculpture of the animal instead of a painting or to accompany the painting so that a complete exhibit might show a skeleton with a painting, a model, a label, a map, and perhaps even another animal such as lives to-day and is akin to the extinct animal.

A map may show the part of the world from which a specimen comes, other maps may show the details of its home country, and maps may be used to show its distribution over the earth and the relation of this region to some other area, as for instance one where certain plants grow. Maps may be mere outlines or shaded, or they may be relief models made to resemble a surface of the country.

Specimens may be arranged in series, and in this way teach much more than they would singly. One may arrange together specimens which illustrate the idea of evolution or which show all the different musical instruments of the world. One may show together all the things found in a certain province or all the animals, plants, minerals and so forth, of a certain region, as for instance a desert, and contrast them with things from a forest.

Different classes of people use museums. Carpenters and cabinet makers often study the collections of woods, miners the collections of minerals, teachers of art and architecture the collections of primitive art and the objects and pictures showing the types of buildings of other times and other peoples.

Some collections are of great value, as for instance the display of gems exhibited by Tiffany and Company at the Paris Exposition. Such a collection is sometimes protected by iron gratings on the windows, and armed guards night and day. Then too there may be electrical connection with the police department so that an alarm may be given either by the guard or when a case is broken open.

Exhibits showing mankind occasionally include plaster casts of living people. Placed on these casts are their clothing, the whole being arranged so that it will illustrate their occupations and their relations to the country in which they live as well as its products, both plant and animal.

Frequently pictures or casts or models must be used where the original specimens are too expensive or too large and heavy to be brought to the museum or even too large to be given space in a museum. Then, too, casts may be used for such things as can not be removed from countries which have silly laws preventing their exportation.

The expeditions of a great museum often cover practically the whole world. The American Museum of Natural History in New York in one year had expeditions in many parts of North America, in South America, Asia and the South Sea Islands.

The specimens too valuable for study to be put on exhibition, duplicate collections which are used for study and the specimens for which there is no room in the exhibition halls are kept in rooms for study where they are safe from changes of climate, insect pests, dust and careless handling. Some of these collections which are never seen by the public, unless they ask to visit the storage rooms, are vast in extent. In a great museum they may be of more value and consist of a larger number of specimens than is found in all the museums put together in a region as large as Canada and the states west of the Mississippi. These collections are of course placed as close together as it is possible to have them and yet be able to get at them for research and for use in illustrating truths to visitors.

When an expedition goes out from a great museum and learns something new, the facts are published in reports which are ofttimes illustrated. This is partly because a single manuscript giving the facts might be burned or lost. These reports are then sent to perhaps a hundred different libraries widely scattered so that they may be available as nearly as possible to all the people of the world. That is, they should be found in such places as London, St. Petersburg, Tokio and Melbourne. It is from such reports that the writers of encyclopedias, text-books and magazine articles secure the knowledge which is finally the common property of all.

A great educational museum always has a library from which its publications are sent out and in which anybody may read works on the subjects covered by the museum. One of the great uses for the museum library is that the staff may always inform itself, for it would not be economical to send an expedition to gather facts about a place if all those facts could be read from books.

After the return of an expedition and after its reports have been published the specimens are put on exhibition together with labels, such a report, popular guide-books, maps, photographs and pictures. Sometimes the results are illustrated by models. Lectures are given to scientific colleagues, to highly educated people, to children, and to the general public, each lecture being made as far as possible appropriate to the audience. The reports contain all the facts, many of which are uninteresting to the public to-day but which would be lost unless published and which may some day be of such great value that they deserve to be saved. These reports are sometimes placed with the exhibits for the use of those who wish to read them, but more often extracts of the more useful and interesting parts are made and published as guide-books for all the people. In some museums such guide-books are given to the public, but as certain classes of people throw them away or destroy them, other museums prefer to charge a small sum for guides. This charge may be less than the cost of the book.

A few museums allow space for special and temporary exhibits and in this way become a sort of headquarters for all kinds of educational expositions such as flower shows, and exhibits illustrating the advance in the fight against the great white plague, expositions of modern sanitary methods and horticultural exhibits. Then too some of the great museums serve as centers for scientific and educational meetings, the large lecture hall being particularly appropriate for general meetings, and the smaller rooms for special societies.

The photographs taken on expeditions are kept in files or in scrapbooks where they may be consulted and copies are given out in small numbers free of cost or in large quantities for the actual cost of the photographs without regard to the expense of the expedition necessary to secure them. These are given to scientists for study and for illustrating their books. They are given to educators to use as illustrations and to hold up before their classes. Many of them are used by magazine writers and newspaper men for illustrations and by sculptors and painters. In this way the explorer brings back glimpses of far-away lands which eventually are shared with people unable to travel or who must travel nearer home.

Vast collections of lantern slides are also maintained in some of the great museums. These are used to illustrate scientific, educational, or entertaining lectures both in the museum and elsewhere. Moving pictures are also occasionally used.

A large lecture hall seating over one thousand people is a useful feature of some of the great museums which also have as a rule several smaller lecture halls. As many as seven or eight lectures may be held in such a museum in one week, as for instance one for the scientist, three in the afternoons for school children, two in the evenings for the general public, and other lectures for certain special classes of people, as for instance those interested in breeding or sanitation.

All the educational work of the museum exhibits is not confined to the inside of a great museum. Special cases of specimens are prepared and sent out to schools, libraries and other suitable places. Sometimes these are loaned indefinitely but very often they are loaned for a week and then moved to another place. In New York this feature of the work became so extensive that an automobile was purchased to transport the collections from the museum to the schools and from school to school, so that thousands of children were reached. This sort of work is somewhat akin to the work of branch banks and traveling libraries.

Many of our people do not appreciate the real use of a museum and we do not wonder at it when we see the dusty, poorly arranged collections in many museums where there are few, if any, labels and the whole tends to disgust, in fact to teach disorder rather than to be pleasing, helpful or educative, but in an up-to-date museum every day you may see classes from kindergartens enthusiastically examining specimens under the guidance of a museum kindergartner. Frequently one may see classes of bright high-school or college students on a visit to the museum halls, supplementing their educational work by viewing the actual things of which they study. They may be guided by a curator. Thousands of slum children in the greater cities are cheered, educated and uplifted by being taken to the museums by their teachers. One time when a lecture was advertised for school children by an enterprising newspaper which offered a prize for the best essay on a certain subject, over seven thousand children endeavored to attend the lecture held in a hall seating only one thousand four hundred, but one of the museum authorities sprang to his telephone and in as many minutes had twelve of the staff taking as many groups of the children to various parts of the building where they were entertained and instructed.

A great educational museum is usually open free to the public every day in the year so that people engaged on certain days may have the greatest possible opportunity to visit it for recreation, education or research. On the occasion of an exhibit for the prevention and cure of tuberculosis, in one museum over forty thousand visitors passed between the police lines in and out of the exhibit in a single day, which proved conclusively that the public is thoroughly alive to the importance and value of the most modern and useful museum work.

Harlan I. Smith
Geological Survey of Canada

THE PROFESSIONAL WORK OF PROFESSOR MORRIS LOEB[1]

Morris Loeb was a man in speaking of whom I wish I might have had time to choose my words with more deliberation. His nature showed itself always in such a refinement as to command its tracing only with the most delicate touch. Tender is the wound in losing a friend in science whom I had known for nearly twenty years,—in fact, since the time he was the secretary of the Section of Chemistry of the American Association at the Brooklyn meeting. At that time he was participating in the great task of habilitating the American Chemical Society, with the history of which no doubt all here are familiar.

I wish I were able to fittingly tell you of the spirit actuating him at that time, as it proved an inspiration to me then, and afterwards served to cement a friendship into a closer personal relationship.

Born and reared in wealth, a great plan in the business world ready for his acceptance, while gaining a broad culture at Harvard, he inhaled the breath of Wolcott Gibbs's scien-

[1] Presented at the October meeting of the New York Section of the American Chemical Society.

tific spirit, which carried him to Hofmann at Berlin. Three papers were published by him while at Berlin, the last being his dissertation.[2] All dealt with carbonyl chloride and its conduct with various amidines. This work was interesting and possessed that normal importance to the candidate for a degree; but Loeb was not satisfied. That was in 1887. The roving ardor of an awakening of physical chemistry was in the air. It carried him to Heidelberg and then to Leipzig to be with Ostwald, who had just made Arrhenius a real power.

By the advice of Ostwald, Loeb undertook to study the molecular weight of iodine in its solutions by the vapor-tension method.[3] His experimental results led him to conclude:

> It seems very probable that iodine in its red solutions has a molecular weight corresponding to I_4, whilst in the violet solution in carbon disulphide there is a less complex aggregation, giving a value between I_2 and I_3.

He found that the method of determining molecular weights by the depression of the freezing-point is preferable to the method by vapor-tensions. He lacked a liquid which would solidify and also dissolve iodine with a pure violet color; but he endeavored to obtain what corroborative evidence he could by experimenting on the freezing-points of iodine in acetic acid and in benzene, although he was eventually forced to give up the attempt by the very slight solubility of iodine in these menstrua at low temperatures. The molecular weight of iodine as calculated from various series of observations seemed to increase continuously with the concentration, so that there was no point in the narrow limits between extreme dilution and saturation at which the molecular weight would appear constant and could be accepted as trustworthy. This was later confirmed by Paterno and Nasini.[4]

With the intention of testing the then latest views on electrolysis, work in which field he had begun with Gibbs, while still at Leipzig, Loeb, with Nernst, carried on a study of the kinetics of substances in solution.[5] From determinations of Hittorf's ratios of transference and the conductivity of a number of silver salts, they calculated the ionic velocity of silver, according to the principles laid down by Kohlrausch. The constancy of the value obtained from observations with eight different salts gave satisfactory evidence for the truth of the theory, the numbers varying only within very narrow limits. Loeb and Nernst also gave the calculated values for the velocities of the other ions, and it further appeared from a comparison with the temperature coefficients of the velocities that they decrease as the velocity increases.[6]

Loeb then felt ready to come back to the master who had changed his course in life and to tell him what they were doing in Europe. So in 1888–9 he returned as voluntary assistant to Gibbs, who had retired from Cambridge to his private laboratory at Newport. After a year, Gibbs realized Loeb's power as a teacher and made him go to Clark University as docent in chemistry.

In a report on "Osmotic Pressure and the Determination of Molecular Weights,"[7] Loeb discussed Raoult's law, the matured papers of van't Hoff on osmotic pressure, the measurement of osmotic pressure, and the methods of determining the molecular weight from the

[2] These papers were: "Ueber die Einwirkung von Phosgen auf Aethenyldiphenyldiamin," *Ber.*, 18, 2427 (1885); "Ueber Amidinderivate," *Ibid.*, 19, 2340 (1886); "Das Phosgen und seine Abkömmlinge, nebst einigen Beiträgen zu deren Kenntnis," Inaug. Dissert., 15 März I. Chem. Labor. d. Berlin Univers.; *Chem. Centr.*, 58, 635 (1887).

[3] "Ueber den Molekularzustand des gelösten Jods," *Z. physikal. Chem.*, 2, 606; "The Molecular Weight of Iodine in Its Solutions," *Trans. Chem. Soc.*, 53, 805.

[4] *Ber.*, 21, 2153.

[5] "Zur Kinetik der in Lösung befindlichen Körper. Zweite Abhandlung. Ueberführungszahlen und Leitvermögen einiger Silbersalze von Morris Loeb und W. Nernst," *Z. physikal. Chem.*, 2, 948.

[6] Loeb also published in this year a paper on the "Use of Aniline as an Absorbent of Cyanogen in Gas Analysis," *Trans. Chem. Soc.*, 53, 812 (1888).

[7] *Am. Chem. Jour.*, 12, 130–5.

vapor-tension. At this time (1890) experimental data to show the value of Beckmann's method had not been published, but Loeb predicted that it would play as great a part as the freezing-point method introduced in its most convenient form by the same chemist.

Shortly afterwards, in a review, Loeb sketched Arrhenius's hypothesis, with some of its logical consequences.[8] He discussed the physical and chemical objections known in 1890, leaving "the task of judging it . . . to those readers who will compare the mass of experimental material and will convince themselves of the simple relations which the various phenomena appear to bear toward each other. As far as this test is concerned," Loeb maintained, "the hypothesis will be found to fulfill its purposes."

In the exact measurement of electric currents, employing the method wherein the determination of the amount of silver deposited from a neutral solution of a silver salt is made, the source of error, particularly where weak currents are concerned, arises from the imperfect adhesion of the silver upon the cathode. The latter is generally a platinum crucible, and Loeb[9] found that a Gooch crucible with asbestos felting over the holes, was a far better form of cathode, providing an arrangement was adopted to hold the solution during electrolysis without leaking. He attained this very satisfactorily by replacing the ordinary platinum cap with a glass siphon of special form.

Then, when but twenty-eight years of age, he was called to the chair of chemistry at New York University. He published a paper entitled "Apparatus for the Delineation of Curved Surfaces, in Illustration of the Properties of Gases, etc."[10]

Professor Loeb thought that, just as an electric system is affected by its approach to or removal from a magnetic field, a reaction which made a system more or less amenable to magnetic action, might show evidence of acceleration or retardation by the magnetic force. He concluded that if this effect were appreciable, the relation between magnetic force and affinity would be established, and data could be obtained for calculating the real value of magnetization. His experimental results, however, were negative, and he was led to believe that no such relation existed, unless it was so slight that his means of observation were inadequate.[11]

It was shortly after this that I met Morris Loeb. He was fired with the zeal of those captain teachers, and his own lighted torch he passed on by students of his who now reflect, in many responsible positions, that spirit of the eighties.

Soon the very heavy responsibilities of a large inheritance fell upon him. Filial duty of meeting those responsibilities, professorial obligations, and research aspirations required the sacrifice of one of the three. The last was sacrificed for a dozen years. The irksome strain of being "by bells directed" began to tell, for to meet them he found it necessary to have his secretary travel with him to take his dictation. One morning he asked me to go with him to the university. We talked things over and he said he would have to give up the professorship, but he would equip a private laboratory in the old Chemists Club, where he would be nearer his philanthropic obligations and might do some research, and *"other things"* perhaps as useful to chemistry as teaching.

In 1905 he published a research on "The Crystallization of Sodium Iodide from Alcohols."[12] He found that apparently the molecular proportion of alcohol assimilated by sodium iodide decreases as the series ascends. The addition products determined were: $NaI \cdot 3CH_4O$; $NaI \cdot C_2H_6O$, and $5NaI \cdot 3C_3H_8O$.

In 1908, ever keeping abreast with the advances in physical chemistry, in a paper on the "Hypothesis of Radiant Matter,"[13] Loeb

[8] "The Electrolytic Dissociation Hypothesis of Svante Arrhenius," *Am. Chem. Jour.*, 12, 506–516.

[9] "The Use of the Gooch Crucible as a Silver Voltameter," *Jour. Am. Chem. Soc.*, 12, 300.

[10] *Jour. Am. Chem. Soc.*, 13, 263.

[11] "Is Chemical Action Affected by Magnetism?" *Am. Chem. Jour.*, 13, 145–153.

[12] *Jour. Am. Chem. Soc.*, 27, 1019.

[13] *Pop. Sci. Monthly*, 73, 52–60.

enumerated the objections which might be urged against the views which then obtained respecting radio-active processes.

In 1909 he assumed the duties of Chairman of our Section. The task of maintaining the high standard of the meetings set by his predecessor was no mean one, for Baekeland, with his customary enthusiasm, had raised the New York Section to its greatest efficiency. Loeb devoted himself to the welfare of the Section with unremitting energy. I am keenly appreciative of what he did for the Section, as it fell to my lot to take up the task where he left it. The opportunities of the office were increased, for he had enlarged the responsibilities, as well shown in his inaugural address that year.[14]

He did publish (1910) a paper on the "Analysis of Some Bolivian Bronzes" (with S. R. Morey),[15] and he wanted to gratify his great love for research and he did have work in progress in his private laboratory; but, in his characteristic fashion, he sacrificed personal desires to do those things he could do and others could not or were disinclined to do. We are assembled in one of the monumental evidences of this immolition.[16] He made possible the new Wolcott Gibbs Laboratory for Physical Chemistry at Harvard. In the *Proceedings* of the American Chemical Society for 1910[17] he published a beautiful obituary of Gibbs, affectionately respectful, rich in reminiscence and earnest in diction. In this hall we have an evidence of his affection for the master. He visited the South American countries in behalf of the recent International Congress of Applied Chemistry. He worked long and hard on important committees in connection with the congress. These were some of the *"other things"* he found to do for chemistry.

[14] SCIENCE, 30, 664.

[15] *Jour. Am. Chem. Soc.*, 32, 652. During 1909–10 Dr. Loeb abstracted the Italian journals for *Chemical Abstracts.*

[16] See Loeb's address at the opening of the Chemists' Club in *Met. and Chem. Eng.*, 9, 177 (1911).

[17] Pp. 69–75.

The shock of Morris Loeb's death still oppresses us; but I am convinced that, as time passes and as we reach a juster evaluation of events, we shall become more and more sensitive of what this man's life really meant, and learn from it what our profession really means. He sought no office; he sought only opportunities to serve his fellowmen. He did it all with a sweet dignity that spells humility. For

Not in hewn stones, nor in well-fashioned beams,
Not in the noblest of all the builder's dreams;
But in the courageous man of purpose great,
There is the fortress, there is the living state.

CHARLES BASKERVILLE

October 11, 1912

THE GEOLOGICAL SOCIETY OF AMERICA

BY invitation of the president of Yale University and the members of its geological faculty and other fellows residing in the vicinity, the twenty-fifth annual meeting of the Geological Society of America will be held in New Haven, Conn., on December 28–31, 1912. The first council meeting is to be held Friday evening, December 27, and the others will be called directly after instead of before the morning sessions as heretofore. Thus the council meetings will cease to interfere with the prompt beginning of the business sessions. The sessions of the society will be held in one of the recitation buildings of Yale University, and the accommodations are so ample that the council is going to try some modifications of the usual program, in an effort to enhance the interest and value of the meeting. The hearty cooperation of the fellowship is needed, however, to make the experiment a success. The morning sessions are to be devoted to papers that promise to be of general interest; the noon recess will be longer than heretofore, in order to give more time for social intercourse, group discussions and the examination of special exhibits; the afternoon sessions will be somewhat shorter than formerly and will be given over to sectional meetings and to papers of less general scope. A special room (or more than one, if needed) will be provided for the display of specimens, the hanging of charts not needed in the public reading of papers, and for similar purposes. The smoking and general conversation room or rooms will be independent of the foregoing. The annual address of the retiring president, Professor H. L. Fairchild, will be delivered on the evening of Saturday, the twenty-eighth. The council desires to increase the number of students and other junior workers in geological science attending the meeting as visitors, and with this object requests each fellow to send to the secretary, not later than November 25, the names and addresses of persons who, whether they can attend the meeting or not, are seriously interested in geology and deserving of recognition as visitors, although they have not yet reached such standing as to gain membership in the society. The council will then write to the persons thus nominated, inviting them to attend the New Haven meeting.

SCIENTIFIC NOTES AND NEWS

Dr. Edward W. Morley, the distinguished American chemist, has been made an honorary member of the Swiss Association for the Advancement of Science.

The gold medal for science of the Prussian government has been conferred on Dr. Robert Helmert, director of the Geodetic Institute of Potsdam.

Dr. E. J. Bartlett, professor of chemistry in Dartmouth College, has been elected representative to the state legislature from the town of Hanover on the Republican ticket.

Dr. Leo Koenigsberger, professor of mathematics in Heidelberg, celebrated his seventy-fifth birthday on October 15.

The Gedge prize of Cambridge University has been awarded to Mr. A. V. Hill, of Trinity College, for his essay entitled "The Heat Production of Amphibian Muscle and of Cold-blooded Animals."

M. d'Oliveira, the Brazilian ambassador to Belgium, has been delivering a course of lectures in several universities and colleges and has been making a special study of the American collegiate educational system.

Professor Merritt L. Fernald, of Harvard University, lectured before the Geographical Society of Chicago on November 8 on "The Mountains and Barrens of Newfoundland and the Gaspé Peninsula."

Professor H. L. Reitz, of the department of mathematics at the University of Illinois, spoke on "The Mathematical Treatment of Scientific Data" before the first College of Science assembly of the year on November 1. The science assembly will be held monthly throughout the year, following the practise instituted last year.

Dr. Fred. E. Wright, of the Geophysical Laboratory of the Carnegie Institution of Washington, will give a course of lectures on experimental geology to the students of the geological department of the Johns Hopkins University, beginning at the opening of the winter term in January, 1913. Dr. Arthur L. Day, director of the Geophysical Laboratory, will cooperate with Dr. Wright in some of these lectures, the general purpose of which will be to present to advanced students in geology this comparatively undeveloped but highly important branch of the subject, attention being directed to the fundamental principles of chemistry, physics and crystallography which underlie work in this field. The results which have already been secured in experimental geology will be reviewed and attention directed to those geological problems which are still unsolved and in which experiment may render efficient aid.

Professor Harold B. Smith, director of the department of electrical engineering of the Worcester Polytechnic Institute, who is on leave of absence and who has recently returned from a trip around the world, was in Worcester recently and delivered three illustrated lectures descriptive of his travels. The first was before the Alumni Association, the second before the Worcester Polytechnic Institute Branch of the American Institute of Electrical Engineers and the third for members of the electrical engineering department and their friends.

The Huxley memorial lecture of the Royal Anthropological Institute will be given on November 19, when Professor W. Gowland, F.R.S., will deliver an address on "The Metals in Antiquity."

The Huxley lecture at the University of Birmingham was delivered on October 30 by Professor John Joly, F.R.S., on "Pleochroic Halos."

A memorial to Dr. D. B. St. John Rosa was unveiled in the Post-graduate Medical School and Hospital, New York City, of which he was the president from its foundation, in 1881, to his death in 1908. The bronze tablet, which represents in relief Dr. Rosa in academic robes, is the work of Mr. Henry Merwin Shrady.

Dr. John William Mallett, F.R.S., professor emeritus of chemistry at the University of Virginia and eminent for his contributions to chemistry, died on November 7, aged eighty years.

Dr. John Monroe Van Vleck, professor of mathematics at Wesleyan University from 1853 until his retirement as emeritus professor in 1904, died on November 4, aged seventy-nine years.

Major General Robert Maitland O'Reilly, U.S.A., retired, former surgeon general of the United States Army, died on November 3.

Mr. Bradford Torrey, the American author of books on natural history, has died at the age of seventy years.

Mr. James B. Parker, of Oxford, known for his work in archeology and geology, has died at the age of seventy-nine years.

Mr. William Bottomley, the nephew of Lord Kelvin, who assisted him in his scientific and engineering work, died on October 19, aged sixty-three years.

The U. S. Civil Service Commission announces an examination for assistant chemist in radio-activity, for men only, to fill vacancies in the Bureau of Mines, at Washington, D. C., or Denver, Colo., at salaries ranging from $1,800 to $2,160 a year. For the same bureau there will be on November 20 an examination for junior alloy chemist at a salary from $1,500 to $1,800.

A Mental Hygiene Conference and Exhibit was conducted at the New York City College by the National Committee for Mental Hygiene and the Committee on Mental Hygiene of the New York State Charities Aid Association. Provision had been made for a large public attendance, and physicians guided parties through the exhibit every half hour, afternoon and evenings. The exhibit, which closed on November 15, was opened on November 8 with addresses by President Finley, Dr. Lewellys F. Barker, Dr. James U. May and Professor George F. Canfield.

We learn from *Nature* that on October 16 a conversazione was held by the Royal Microscopical Society in the great hall of King's College, about four hundred fellows and guests being received by the president, Mr. H. G. Plimmer, F.R.S., and Mrs. Plimmer. The object in view was, so far as practicable, to gather together a series of exhibits which would indicate the many uses, both in science and commerce, to which the microscope is put at the present time. In addition, the conversazione afforded an opportunity for those engaged in microscopic work to show objects of interest or to demonstrate the use of apparatus or appliances for special purposes.

The International Photometric Commission, commonly known as the "Zurich Commission," was created by the International Congress of Gas Industries which convened in Paris in 1910. This commission, composed of representatives from the various national technical gas societies, with the cooperation of certain of the national laboratories, has been concerned with general questions of photometry in addition to its more specific functions in connection with the photometry of the incandescent mantle. Inasmuch as there has developed a wide-spread appreciation of the need of an international, thoroughly representative commission to deal with general questions of photometry, and possibly also of illumination, it has been proposed that the International Photometric Commission be reorganized to fulfill these requirements in a way acceptable to all photometric interests. This movement is being well received, both in Europe and America. President Vautier, of the International Photometric Commission, has requested the sub-commission on photometric units and standards to formulate a plan of reorganization. This sub-commission was originally appointed at the 1911 session of the International Photometric Commission to consider the recommendations of the Illuminating Engineering Society (U. S.) regarding photometric nomenclature and standards. The sub-commission at present is composed of the following members: Dr. Brodhun, Dr. Kusminsky, M. F. Laporte, Mr. C. C. Paterson, secretary, M. Th. Vautier, *ex-officio,* and a representative of the United States soon to be appointed. The personnel of the sub-commission, composed of representatives of the various national laboratories, is peculiarly qualified to undertake the duty of formulating plans of reorganization. It is hoped that as the outcome of the efforts of the sub-commission, with the endorsement of the various national technical gas societies to which the International Photometric Commission in the past has been responsible, an essentially new commission will be formed which will be equally representative of and responsible to all national technical gas, electric and illuminating engineering societies, and other bodies interested in photometry and illumination.

There was a decrease of nearly 28 per cent. in the production of iron ore and a smaller but noteworthy decrease in the production of pig iron and steel in the United States in 1911, compared with the production in 1910, due to the large over-production of ore in 1910, and to a lessening demand for iron products in 1911. The prospects for 1912 are encouraging, according to Ernest F. Burchard, of the United States Geological Survey, in a report on the "Production of Iron Ore, Pig Iron and Steel in 1911," but at no time since 1907 has the excessive capacity for manufacturing iron and steel been fully utilized, and nothing short of abnormal activity, which is not likely to occur in 1912, will result in employing the full capacity of the plants. One of the important features of the iron-ore industry in 1911 was the increased attention paid to the conservation of ore in the Lake Superior region through beneficiation (washing, concentrating, roasting, nodulizing and briquetting of ores). The iron ore marketed in the United States in 1911 amounted to 40,989,808 long tons, valued at $86,419,830 at the mines, compared with 56,889,734 long tons, valued at $140,735,607, in 1910. Minnesota and Michigan produced the bulk of the iron ore, the former 23,398,406 long tons and the latter 8,944,393 long tons. During the year 159 mines produced over 50,000 long tons of iron ore each, compared with 191 mines which exceeded that output in 1910. The largest quantity produced by any single mine in 1911 was 1,553,510 long tons, from a mine at Marble, Minn. The production of pig iron in 1911 amounted to 23,257,288 long tons, valued f. o. b. at the furnaces at $327,234,624, compared with 26,674,123 long tons, valued at $412,162,486, in 1910, a decrease in quantity of 3,416,835 tons and in value of $84,827,862. Pennsylvania produced the greatest quantity of pig iron, 9,581,109 long tons; Ohio was second, with 5,371,378 long tons, and Illinois stood third, with 2,036,081 long tons. The total quantity of steel produced in 1911 was 23,675,501 long tons, against 26,094,919 long tons in 1910. The bulk of it came from Pennsylvania, whose output was 13,207,539 long tons.

The United States Geological Survey has recently published, as an advance chapter from "Mineral Resources of the United States for 1911" a report on the mine production of silver, copper, lead and zinc in the central states in 1911, by B. S. Butler and J. P. Dunlop. The total value of the output of these metals in the central states in 1911 was $64,-519,444, nearly half of which came from Missouri, whose production was valued at $30,-171,311. The value of the output of Michigan, the second largest producer, was $27,743,572. The production of silver in the central states in 1911 was 550,184 fine ounces, valued at

$291,598, compared with 365,702 fine ounces, valued at $197,479, in 1910. Of the 1911 production 497,281 ounces came from the copper lodes of Michigan. The output of copper from the central states in 1911 came from the states of Michigan and Missouri and amounted to 220,480,513 pounds. Of this production 219,840,201 pounds came from Michigan. The mine production of lead in the central states in 1911 was 188,669 short tons, which, rated at the average New York price for the metal for the year ($90 a ton), was valued at $16,980,210, compared with 171,226 short tons, valued at $15,067,888, in 1910. Missouri produced 95 per cent. of the yield of the central states and about 44 per cent. of the primary lead recovered in the United States from domestic ore. The production of zinc in the central states in 1911, based on mine returns with a deduction for separating and smelting losses, was 172,698 short tons, valued at $19,687,572; the production for 1910 was 178,784 short tons, valued at $19,308,672. Missouri was the largest producer of zinc in the United States, although its production, 122,515 tons, was slightly less than in 1910.

UNIVERSITY AND EDUCATIONAL NEWS

WORK has been begun at Harvard University on the three freshman dormitories which are to stand near the bank of the Charles River, south of the main body of university buildings. It is understood that Mrs. Russell Sage is one of the large contributors to the fund of $1,800,000 which is now nearly completed for these dormitories.

GROUND has been broken for the north wing of the new electrical laboratory of the Sheffield Scientific School. It will cost about $115,000, of which $75,000 is a gift made by A. C. Dunham, Yale, '54, of Hartford, Conn.

THE trustees of Wesleyan University have voted to build an astronomical observatory at a cost of $60,000.

THE Queen Wilhelmina chair in Dutch history, literature and language will be established at Columbia University, supported jointly by the university and by funds raised for the purpose in Holland.

THE first event in the opening of the Peter Bent Brigham Hospital at the Harvard Medical School was the opening of a class for nurses in the ward building on October 31. On the same date the hospital took over the Harvard Clinic, which will be the first continuous clinic in Boston. Patients will be admitted to the hospital about the middle of January.

ON October 23 the corner stone of the library and administration building for the University of Utah was laid with appropriate ceremonies. This building is to occupy the central position at the head of the street upon which the campus faces. The superstructure will be of Sanpete oolite, and the foundation of Temple granite from Little Cottonwood Canyon. When completed it will house the library, the administrative offices, the art gallery, the archeological museum and a spacious auditorium, as well as rest rooms for men and women. The cost will be more than $300,000.

A RECENT analysis of the professional distribution of the graduates of Oberlin College reveals the fact that teaching has been the most prominent field of endeavor. The total number of graduates of the academic department, including men and women, is 3,385 (when the same person has taken more than one degree he has been considered but once). Of these, 1,244, or 36.8 per cent. have gone into the profession of teaching. If the group of unclassified is left out of consideration, thus omitting many women with no profession, the proportion of graduates entering teaching is even more striking, since one out of every two has become a teacher. From a total of 1,682 men graduating from the academic department, 392, or nearly 25 per cent., were teachers. Of the women, 853 out of a total of 954 classed in any profession have taught.

PROFESSOR T. J. HEADLEE, head of the department of entomology and zoology in the

Kansas State Agricultural College and Experiment Station, has resigned to become state entomologist of New Jersey, succeeding the late John B. Smith. In Dr. Headlee's place at the Kansas College and Experiment Station, Geo. A. Dean, M.S., has been placed in charge of entomology and Robert K. Nabours, Ph.D. (Chicago), in charge of zoology. Further promotions and additions in the department have been as follows: John W. Scott, Ph.D. (Chicago), has been promoted from instructor to assistant professor of zoology; Maurice C. Tanquary, Ph.D. (Illinois), has been appointed instructor in entomology, and Mary T. Harmon, Ph.D. (Indiana), in zoology and J. W. McColloch has been appointed assistant entomologist.

Dr. C. J. Steinmetz, formerly managing editor of *Country Life in America*, has been appointed assistant professor of landscape horticulture at the University of Illinois, and Ralph Rodney Root, of Harvard University, has been appointed instructor. A number of prominent specialists in landscape gardening will lecture before the students this year; Mr. Charles Mulford Robinson, a specialist in city planning, will lecture for two weeks beginning on November 8. There are thirty students in the four-year course in landscape gardening and one hundred and fifty in the elementary course.

The vacancy in the staff of the mechanical engineering department of Lehigh University, due to the death of Assistant Professor E. L. Jones, has been filled by the appointment of R. L. Spencer, B.S. Mr. Spencer is a graduate of the Iowa State College, where he has taught for three years.

Bartgis McGlone, Ph.D. (Hopkins, '07), has been appointed associate in physiology and embryology at the College of Physicians and Surgeons, Baltimore.

Among the committees appointed by the board of overseers of Harvard University for the year 1912–13 are the following:

The Medical and Dental Schools—J. Collins Warren, George B. Shattuck, Charles W. Eliot, Alexander Cochrane, William Sturgis Bigelow, Henry H. Sprague, Henry Saltonstall Howe, William L. Richardson, Charles P. Briggs, James C. White, Charles H. Tweed.

The Bussey Institution—Carroll Dunham, Walter C. Baylies, J. Arthur Beebe, John Lowell, Nathaniel T. Kidder, Augustin H. Parker, William H. Ruddick, Isaac S. Whiting, Simon Flexner, Daniel W. Field, Warren A. Reed.

The Observatory—Joel H. Metcalf, George I. Alden, Mrs. Henry Draper, Edwin Ginn, George R. Agassiz, Elihu Thomson, Erasmus D. Leavitt, Charles F. Choate, Jr., Charles R. Cross.

The Museum of Comparative Zoology—J. Collins Warrent, George P. Gardner, Dudley L. Pickman, Rodolphe L. Agassiz, John C. Phillips, J. B. Henderson, Jr., Louis J. de Milhau.

The Peabody Museum—George D. Markham, Charles P. Bowditch, Augustus Hemenway, Jesse W. Fewkes, Clarence J. Blake, Clarence B. Moore, Elliot C. Lee, Louis J. de Milhau, John C. Phillips, Thomas Barbour, Robert G. Fuller.

The Jefferson Physical Laboratory and Department of Physics—Howard Elliott, Elihu Thomson, Erasmus D. Leavitt, Elliot C. Lee, Samuel Hill, Hammond Vinton Hayes.

The Chemical Laboratory—J. Collins Warren, Clifford Richardson, Elihu Thomson, Charles H. W. Foster, John D. Pennock, Alexander Forbes.

On Geology, Mineralogy and Petrography—George B. Leighton, Rodolphe L. Agassiz, George P. Gardner, William E. C. Eustis, Raphael Pumpelly, William Sturgis Bigelow.

On Zoology—William L. Richardson, Augustus Hemenway, William Brewster, Alexander Forbes, John E. Thayer, Dudley L. Pickman, Francis N. Balch, John C. Phillips.

On Botany—Nathaniel C. Nash, George G. Kennedy, Walter Deane, Edward L. Rand.

On Mathematics—William Lowell Putnam, George E. Roosevelt, George V. Leverett, Philip Stockton.

DISCUSSION AND CORRESPONDENCE

THE MEANING OF DRIESCH AND THE MEANING OF VITALISM

Professor Jennings's letter in Science of October 4, 1912, contains some comments on an article by the present writer, published in Science, July 21, 1911. These appear to manifest some misapprehension, confirmed by some inadvertent misquotation, of the article in question; and to convey, accordingly, an erroneous impression both as to what was said, and as to what is the fact, concerning Professor Driesch's view of the relation of vitalism to indeterminism.

With respect to the article upon which he animadverts, Jennings declares or plainly implies: (1) that it purports to be an account of Driesch's personal views concerning the relation of vitalism to "experimental indeterminism," but that what it gives "is in reality an exposition of the conclusions which Lovejoy himself might draw from Driesch's data, assuming these to be the conclusions which Driesch draws"; (2) that in consequence of this confusion the article erroneously maintained that Driesch is not an "experimental indeterminist." Both these assertions require correction.

1. The article expressly distinguished between Driesch's actual views as a whole, and the conclusions which I regard as properly inferrible from a single one—though the most emphasized and most characteristic one—of his arguments. For the exposition of the former I disclaimed responsibility, remarking that I did "not wish to complicate the discussion with exegetical inquiries into the precise meaning of a rather difficult writer." My discussion was explicitly limited to the morphogenetic data brought together in "The Science and Philosophy of the Organism," to the exclusion of the arguments from animal behavior, which are more markedly indeterministic in their tendency. I endeavored to point out the real "conclusions suggested by Driesch's analysis of what is implied by the totipotency of parts," etc., to show "all that it logically *need* imply"; and the reader was definitely informed that these logically necessary implications of Driesch's premises fall short of the conclusions which he at times deems himself entitled to draw.

I do not say that Driesch himself clearly and consistently adheres to this assumption [*i. e.*, that his entelechies, supposing them to exist, act in a uniform manner and in correlation with specific physico-chemical complexes]; but in so far as he departs from it and gives color to the charge of indeterminism, he introduces a foreign element into his conception of a "harmonious equipotential system," and confounds the second sort of vitalism with yet a third essentially distinct one [*i. e.*, with experimental indeterminism]. And this is one of the confusions which it is needful to guard against in the discussion (p. 78).

The reader of Jennings's recent letter would certainly gather that I had failed to make this distinction, and would never guess that the article under discussion contained such a passage as that just cited. Jennings, in fact, takes from the article sentences referring to what I urged were the only proper inferences from Driesch's premises, divorces these sentences from their context, and cites them as evidences of my misconception of the actual and total position personally held by Driesch. He quotes, for example, the phrase "a closer scrutiny of the doctrine's implications," etc.; the "doctrine" here referred to is *not*, as he assumes, Driesch's entire system of vitalism, but a more limited doctrine, formally defined in the preceding paragraph.[1] In two other cases Jennings cites disconnected sentences and assigns the demonstrative pronouns in them to antecedents other than those intended.

2. It is, however, true that two passages in the article referred directly to Driesch's actual position. One of these, already quoted, consisted in the admission that Driesch in fact, though without warrant from his premises, at times construes his vitalism as equivalent to experimental indeterminism. The other was an *obiter dictum:* "though I think Jennings misconceives Driesch's position in ascribing to him a wholesale 'experimental indeterminism,' I do not wish," etc. Against this Professor Jennings now quotes letters from Professor Driesch in which the latter frankly calls himself an experimental indeterminist. Since I had elsewhere in the article noted that he

[1] It was to this kind of vitalism, as defined in my earlier paper—"the second kind of vitalism distinguished by Lovejoy"—as well as to Driesch's personal doctrine, that Jennings in his previous article imputed indeterministic implications (SCIENCE, June 16, 1911, pp. 927–28).

was such in some sense and to some degree, I should have supposed that Professor Jennings would have given consideration, in reading this phrase, to the qualifying adjective "wholesale." By a "wholesale indeterminism" I intended to designate precisely that extreme doctrine which Jennings in his paper had apparently ascribed to the author of "The Science and Philosophy of the Organism." That doctrine Jennings had formulated as follows (italics mine):

All living things are complexes of great numbers of chemicals so that *the conditions under which entelechy comes into play are always realized.* We may therefore *expect its action at every step in our work;* we must be prepared *at all times to find the same physical configuration giving rise now to one result and now to another.* (Science, June 16, 1911, p. 932.)

Such a view would mean that, in organisms, not merely behavior but also all morphogenetic and psychological processes would be absolutely variable and unpredictable, that no amount of past experience of vital phenomena would justify even the slightest anticipation of any uniformity in their future sequences. This doctrine, if accepted, would, as Jennings rightly points out, make biology as a science impossible and compel us to regard biological investigators as engaged in a "hopeless task" (*ibid.*). If Driesch adheres to this "wholesale experimental indeterminism," and takes this extreme view of the impossibility of generalization and prediction in biology, I must frankly confess that I had *not* gathered the fact from his Gifford lectures. And I must add that I even yet remain unconvinced that he does so. If he does, he ought in consistency to lead a movement for the suppression of physiological laboratories. I am strengthened in my disbelief that Driesch cherishes any such fell designs against the happiness of experimental investigators in biology by the fact that another letter of his to Professor Jennings—which the latter does not quote, but which he has kindly permitted me to see—contains the following words:

Practically, we may say that complete knowledge of the physico-chemical constitution of a given egg in a given state and of the behavior following this constitution in one case, implies the same knowledge for other cases (in the same species) with very great probability. But this is a probability *in principle* and can never be more. It would not even be a probability, in the case that we did not know the origin (or history) of a given egg in a given state, viz., that the egg is the egg of, say, an ascidian. But to know this history or origin *is, of course, already more than simply to know "the physico-chemical constitution"* and its consequences in one case (what suffices in the realm of the unorganic). It *may* be that the eggs of fishes, echinides and birds are the same in all *essentials* of the physico-chemical constitution.[2] There happens something very different in the different cases on account of the different "entelechies." In spite of this, we know what will happen with great probability from one case if we know that this egg "comes from a bird" and that the other "comes from an echinid." . . . Therefore, *practically,* "experimental indeterminism" is not a great danger for science. [Italics in the original.]

This appears to me to be a tolerably pertinent passage, which might well have been included among Jennings's selections from his correspondence with Driesch. It seems equivalent to a statement that the sort of indeterminism which Driesch professes is virtually negligible, so far as the every-day, practical purposes of the experimentalist are concerned. If Jennings had considered this passage in connection with the others which he quotes, he would not, I am sure, have contended that "Dr. Driesch's statements of the matter are fully as strong" as his own: they obviously fall very far short of his own. The experimental indeterminism in them is not at all of the "wholesale" sort.[3] Possibly Jennings holds

[2] The reader will observe that this particular proposition Driesch gives as merely possibly true. It has, in fact, no sort of logical connection with his arguments from morphogenesis and restitution. Not only do those arguments not prove this conclusion, they do not even suggest it.

[3] In published writings Driesch uses language which seems to express a yet more definite repudiation of wholesale experimental indeterminism. Thus in *Die Biologie als selbständige Grundwis-*

that one who admits that there is any "experimental" indeterminateness in any organic process can not consistently stop short of the extreme view he has himself defined. But he has scarcely proven this; and in any case, if he imputes the acceptance of this view to Driesch, he is identifying the conclusions which he himself might draw from certain of Driesch's positions (if he held them) with the conclusions which Driesch draws.

I am afraid the foregoing shows that Professor Jennings has, after all, succeeded in luring me into "exegetical inquiries into the precise meaning of a rather difficult writer." However interesting these may be, there are other questions in which, I confess, my interest is more acute—as, no doubt, Professor Jennings's really is also. Among these is the question: What do the data chiefly emphasized by Driesch *really* tend to prove about organisms? On this, which was the principal theme of my previous communication on the subject in Science, Professor Jennings's recent letter has little to say. Yet I think that his letter leaves the matter in a not wholly satisfactory logical condition; and that there is a good deal more which might with advantage be said, in the interest of a full clearing up of this genuinely significant issue. But that undertaking, to which I hope before long to attempt to contribute elsewhere, would call for a lengthier disquisition than would be suitable for publication in this journal.

Arthur O. Lovejoy

The Johns Hopkins University,

October 15, 1912

senschaft, 1911, he defines biology as a *Gesetzeswissenschaft*, which has for its most fundamental part "the doctrine of the laws of morphogenesis." And he speaks of these laws as discoverable through *gewisse Sondererfahrungen.* Vitalism, he adds, "never means *Gesetzlosigkeit*" (pp. 34, 37, 39).

WINTER WEATHER IN FLORIDA

Under the above caption in Science for May 31, 1912, Mr. Andrew H. Palmer submitted some observations on Florida weather. The winter of 1911–12, in Florida, was by no means severe, but the temperature averaged low during January and February, as compared with the normal, the monthly departures during the winter months being: December, $+5°.1$; January, $-0°.6$, and February, $-4°.6$.

Mr. Palmer's statement that "Florida's climate did not receive careful attention until large numbers of settlers were attracted by the recent land-boom," is rather gratuitous. For forty years the weather bureau records of Florida have been consulted by people of broad intelligence in their search for truth, regarding the climatology of the state. With regard to the statement: "In all but eight of the last seventy years freezing temperatures have occurred in Jacksonville," a few supplementary facts are essential to a correct understanding. Mr. Palmer's figures were correctly copied from "Climatology of the U. S.," but included in that report were miscellaneous records that antedate those of the weather bureau, and, though given official cognizance to the extent of publication, yet, the official life of local weather bureau data begins with the establishment of a station in Jacksonville in 1871. The records previous to 1871 were mostly by voluntary observers, and they are not recognized as coordinate in importance with those compiled under official supervision during subsequent years; hence, to a certain extent, they are taken *cum grano salis.* A freezing temperature in Jacksonville is not followed, necessarily, by similar conditions in the citrus belt for Jacksonville sustains, approximately, the same relation to the rest of the state as Sacramento, California, does to the San Diego section.

The above qualifications are pertinent also in the matter of snowfall in Florida. During the severe blizzard of February, 1899, snow fell over the extreme northern portion of the State to the depth of several inches; that is, over an area of slightly more than 1° in latitude. This was the heaviest snow fall in Florida of which there is authentic record, and it is believed to be an expression of maximum intensity along that line. Certainly it was not exceeded during the century.

Mr. Palmer points out further: "The St. Johns River was frozen." My, that was a cold wave, indeed! The St. Johns River is from 1 to 5 miles wide, and 20 to 40 feet deep, with the usual tidal conditions that obtain in streams contiguous to the ocean. That this river, in latitude 30° North, should freeze over is a new science item of wonderful potentiality. Ice may have formed near the fringe of the river during the severe weather of 1835, but the St. Johns freezing, never! "Climatology of the U. S.," by Professor Henry, stated: "The St. Johns was frozen several rods from the shore," quite a distinction from: "The St. Johns was frozen."

As to the formation of frost at Miami on February 11, 1912, as alleged by Mr. Palmer, it is sufficient to say that the minimum temperature at Miami on the date named was 51°.

Florida covers an area of about 6° in latitude. Winter storms of the southwest type occasionally dip far southward, and, when followed by "highs" of great magnitude, it is obvious that wide temperature ranges must be the sequence to the rapidly shifting areas of high and low barometric pressure. Be it remembered, however, that most of the cold waves that reach the gulf coast leave no icy touch over the lower peninsula. The great upper drift seems to pull the northern portion of our "highs" more rapidly eastward than the southern portion, thereby frequently converting what appeared, primarily, as an ominous condition into a harmless change of northeast winds and cloudy weather.

In contrasting Florida and California as winter resorts, Mr. Palmer was unfortunate in his citation of temperatures, and, inferentially at least, left the impression that California, during the winter of 1911–12, was the elysian field of climatic perfection. Invidious comparisons are not in good taste, but weather bureau records are paths that lead to truth, so let the record speak. Mr. Palmer states that 42° was the lowest temperature recorded at Los Angeles during January. Official records show, however, that 39° occurred on February 27, and 38° on December 31, 1911, and these figures represent a state of inversion, the temperature nearer the ground being 8° to 10° lower. In fact, Riverside recorded 21°, San Bernardino, 19°, and Redlands 24°, on December 26, 1911. The temperature of —2° at Tallahassee, Fla., in February, 1899, occurred during a condition that marked an epoch in the climatic history of the country. Tallahassee, however, is in the "hill country," quite 200 miles from the citrus belt. Coincident with the zero temperature at Tallahassee, were minima of only 24° to 28° in what is now an important section of the citrus belt.

Parenthetically, I will say there is no issue between California and Florida. Their inheritance and common destiny are the same. Florida rejoices in California's countless resources and great prosperity, and forsooth, she has learned a lesson from her business acumen and studied frugality. Aye, more. Florida is even willing to follow where California leads, provided the objective be unity and prosperity, justice and equality.

Florida's hopes and aspirations are not builded on the misfortunes of others, but, like California, they rest securely in the public's knowledge of her resources, and in the wonderful possibilities arising from a climate that offers success to the industrious, hope and comfort to the afflicted.

Florida, however, has her "ups and downs." The cold wave of December, 1911, so damaging to the Pacific coast, did not reach this state, but its counterpart is found in the cold waves of the '90's, which swept this section with great severity.

The matter of the weather recurring in cycles has not been established as a fundamental fact, Bruckner to the contrary, notwithstanding. The "long ranger" has spent his force, and until puny man is able to revolutionize the mechanics of the atmosphere, the rain-maker will continue to bombard space with negative results. Hence, we must continue to rely on that governmental agency, the weather bureau, for timely warnings of impending changes. Light-wood knots are still plentiful in Florida, and coal and oil seemingly so in California. The utilization of these, supplemented by intelligent action, will circumvent, to a large extent, any lasting damage from even extreme boreal conditions.

A. J. Mitchell   Jacksonville, Florida

SCIENTIFIC BOOKS

The Life of Ellen H. Richards. By Caroline L. Hunt. Boston: Whitcomb and Barrows. 1912. Pp. xiv + 329.

It is seldom that a biographer is confronted with a more difficult task than that of bringing together in moderate compass a record of a life of such unremitting, aggressive and varied activity as that of Ellen Henrietta Richards. In this instance, however, both author and publishers have been inspired by warm, personal friendship to prepare a memorial which should give worthy expression to the ideals, purposes and deeds of this most remarkable woman, and the outcome is a volume which will gratify the legions of those who, because of personal contact or helpful inspiration, will always count Mrs. Richards among their friends.

The preparation of this memorial volume was undertaken, at the request of Professor R. H. Richards, through the cooperative efforts of a committee of nine of Mrs. Richards's intimate associates. They have gathered materials from many sources, including family records, letters from classmates, college associates, graduates and former students of the Massachusetts Institute of Technology, friends in all walks of life, and from the officers and records of the many organizations in whose activities she took a leading part. From this material Miss Hunt has prepared a most readable and interesting narrative. This she has subdivided into sketches, in separate chapters, relating, respectively, to Mrs. Richards's childhood, girlhood, college life (two chapters), her experiences as a student of chemistry, her laboratory work, her home life, her association with the Woman's Laboratory, her teaching by correspondence, the beginnings of euthenics, her work among and for college women, her activity as a missionary of science, her journeyings, her activities in connection with the Lake Placid Conference, and with the Home Economics Movement. The remaining two chapters of the book deal with the enlarged influence of the last years of her life and the fortunate perpetuation of that influence in the future through the continuation of the helpful activities which she organized and inspired, and which others are now maintaining with enthusiasm.

It is obviously too early to estimate accurately the full measure of what Mrs. Richards accomplished, but this disadvantage is more than offset by the opportunity to obtain accurate information at first hand from many reliable sources, and by the enthusiastic zeal of so many to do honor to the memory of one who had so recently been to them a source of inspiration and help.

Even to those most closely associated with Mrs. Richards, who witnessed her untiring energy and devotion to her work and her ideals, the story of her life, as told in this volume, must excite renewed wonder and respect. It is a singular record of severe and often disheartening obstacles overcome by patient purpose and ceaseless effort, inspired and supported by a breadth of thought and outlook which was distinctly in advance of the period in which she was working. This is strikingly true of her girlhood and young womanhood, where she was a pioneer in her undertakings with respect both to her own education and development and that of her fellow-women; and it is hardly less true of the work of her later years for the improvement of life in the community, and especially in the home. Her viewpoint had much in common with that which in other fields leads to the inception of large engineering operations of wide significance. Whether as teacher, investigator, organizer, missionary, companion or friend, her efforts were essentially constructive, and, while the results may lack something of the tangible permanence and glory which belong to the creations of the engineer, they are none the less abiding and real. It is a pleasure to note that two memorial funds, the proceeds of one of which is to be used for the endowment of research along those lines of the chemistry of sanitation in which she was interested, and the other to be used in the interests of Home Economics, are already of considerable size, and, if still further supported, will do much to perpetuate her life work.

If the zeal of the biographer has occasionally (though seldom) led to the use of ultra-superlatives, it is far more frequently true that, in the compass of such a work as this, it has been impossible to do full justice to her attainments in so many fields. The volume is amply illustrated (the frontispiece being a most excellent photograph of Mrs. Richards, taken near the close of her life) and it can hardly fail to be a source of gratification to all concerned with its preparation. It is a book which should be widely read and from which much pleasure and profit is sure to be derived.

H. P. Talbot

The Examination of Prospects. A Mining Geology. By C. Godfrey Gunther. New York, McGraw-Hill Book Company.

This book, which is attractively bound in flexible leather as a pocket manual of 221 pages, presents the practical side of the geology of metalliferous ores, excepting iron and placers. Sound advice is given on the procedure of the examination and sampling of mines, and especial attention is devoted to the outcrops and structural features of ore deposits.

The writer states at the outset that a great proportion of the deposits having outcrops of commercial grade or of evident promise have already been recognized and explored. Rich discoveries at the surface belong to pioneer days, and as time goes on the more important developments are the result of lower working costs, improved metallurgical processes, and of an increasing knowledge of economic geology. As engineers in search of developed mines no longer expect to find properties having positive ore of greater net value than the price asked, so those in search of prospects should not expect to find proved ore-shoots awaiting their recommendation. There is usually local capital for the preliminary development of a patently good prospect, and most of these are steadily worked from the time of their discovery until some apparently unfavorable development shuts off the supply of local capital. These statements recall one frequently heard that "all mines are poor at the bottom." The basis is partly geological and partly psychological, for men seldom stop digging when in bonanza. A great majority of prospects have been examined again and again, presumably by men who commanded a knowledge of sampling, the services of an assayer, and at least an elementary knowledge of geology. In order to pick a good prospect from those rejected by his predecessors, therefore, an engineer must base his hope of success upon superior geological training.

Although the author does not attempt a genetic classification of ores, he does present in a logical and effective manner a mass of carefully chosen and ably digested material.

The treatment of the superficial alteration of ore deposits and the secondary enrichment of copper, silver and gold ores is concise and clear; but in view of Stokes's experiments in the solution of gold in ferric salts, the statement that gold is dissolved in solutions of ferric hydrate would seem to demand experimental proof. Numerous examples are cited of changes in value and character that have been noted as ore lodes are followed in depth. The many text figures, which are well chosen and well executed, add greatly to the attractiveness and value of the volume, and both the author and publisher are to be congratulated on its appearance.

W. H. Emmons

Minneapolis

SPECIAL ARTICLES

NOTE ON THE DEVELOPMENT OF AMPHIBIAN LARVÆ IN SEA-WATER

That the amphibia are poisoned by common salt, and hence geographically restricted to regions free from this substance, is a general belief, apparently so well supported by observation and experiment, that the contradictory evidence brought forward recently by Pearse[1] seems at first sight enigmatical. However his discovery of frog larvæ in three pools of an estero, or small creek opening into Manila Bay, is capable of explanation although, because of osmotic difficulties, it is impossible to carry out the necessary experiments quantitatively on forms which do not live equally well in fresh and salt water.

The three analyses reported by Pearse are not strictly comparable, and in the calculation of the NaCl from the total Cl no standard of reference is given, nevertheless it follows from recalculation on the basis of Forchheimer, that the solutions dealt with must have been, as stated by Pearse, roughly, 2.6 per cent., 2.1 per cent. and 1.1 per cent. NaCl respectively.

As the larvæ were found in a tidal area where fresh and salt water meet, it is not probable that they were exposed continuously during their development to the amounts of NaCl given, but it is probable that they developed in a medium never free from this salt, and that despite the fact that .6 per cent. is ordinarily sufficient to prevent gastrulation.

Acclimatization to Osmotic Pressure.—A dilution of .85 per cent. NaCl (.25 per cent. less than the weakest solution reported) causes the death of 87 per cent. of the larvæ of *Rana pipiens* exposed to it for eighteen hours, whereas a solution of twice this strength kills 97 per cent. in three hours, and is therefore six times more fatal than the weaker solution. This fatality, however, depends on osmotic pressure, for both solutions brought about shrinkage, and an associated slowness and feebleness of reaction to touch. In the stronger solution these symptoms were more pronounced, and came on more quickly than in the weaker. Death resulted, therefore, probably more from dehydration than from the specifically poisonous effects of the NaCl.

These results led to an attempt at acclimatization by successively halving the .85 per cent. solution, until only one sixteenth its original strength. With this three series of tests were begun, involving fifteen larvæ. The results are given in tabular form as follows:

After	32	21	24	24	24	hours
in NaCl	.053125	.10625	.2125	.425	.85	per cent.
there were	15	14	12	10	0	survivors.

Time of acclimatization 101 hours.
Average strength of preparatory solution .199 per cent.

From control observations I found that 24 hours is just about the limit of endurance in the .85 per cent. solution, whereas without acclimatization 18 hours is the limit. Life, therefore, can be prolonged one third by a preliminary slow passage through weaker solutions. From this I conclude that the ability of amphibian larvæ to exist in sea water depends on their not being introduced into the stronger solutions too suddenly. This desideratum can certainly be fulfilled in an estero. These experiments leave entirely open the question of racial acclimatization which is probably of great importance.

The Antagonistic Effects of Calcium.—As Loeb[2] has repeatedly pointed out, very small quantities of Ca suffice to antagonize the poisonous effects of NaCl. Thus he found that in 100 c.c. of 5/8 M NaCl the eggs of *Fundulus* failed to develop, whereas when he added 4 c.c. of an M/64 $CaSO_4$ solution, 75 per cent. of the eggs formed embryos. From this it follows that one molecule of $CaSO_4$ is sufficient to antagonize 1,000 molecules of NaCl. It does not of course necessarily follow that this will prove true with other organisms, nor must we forget that other ions have been shown to antagonize the Na, but the antagonism of the Ca against the Na is so strong in the case of *Fundulus* that it is only natural to try this first in the case of the frog larva.

[1] Pearse, A. S., "Concerning the Development of Frog Tadpoles in Sea Water," *Philippine Journal of Science*, Vol. VI., No. 4, Section D.

[2] "Dynamics of Living Matter," p. 47.

The deleterious effect of a 1.7 per cent. NaCl solution to which .09 per cent. $CaSO_4$ had been added proved, as one might expect, greater than that of the pure NaCl solution. Even when diluted one half 93 per cent. of the larvæ died in 13 hours. However, preliminary treatment with more dilute solutions, even for a relatively short time, not only practically doubled the time during which the larvæ can endure the .85 per cent. solution, but only 7 per cent. died in 24 hours. In tabular form:

After	12	11	11	24	hours
in NaCl	.10625	.2225	.425	.85	per cent.
in $CaSO_4$	.005625	.01125	.0225	.045	per cent.
there were	15	15	15	14	survivors.

Time of acclimatization 34 hours.
Average strength of preparatory solution in Na .248 per cent.
Average strength of preparatory solution in Ca .013 per cent.

Comparing this result with the first acclimatization, it is seen that when Na and Ca are present roughly in the proportion of 50 to 1, the tadpoles may be acclimated to the .85 per cent. solution about three times as fast as in the absence of the Ca, and furthermore that 93 per cent. of the larvæ so treated can endure this solution for 24 hours, whereas, in the absence of Ca, none survive. Although the concentrations here dealt with are lower than those reported by Pearse, although not much lower than his weakest solution, the proportion of Na to Ca is, according to Forchheimer, identical.

Other Antagonisms.—In a series of investigations Loeb and Wasteneys[3] have demonstrated and measured the antagonistic effects of KCl and NaCl on *Fundulus*, so that in view of the fact that the findings with reference to Ca can be verified on the frog larva, it seems reasonable to assume similar relations for the K and Na. For Mg this is certainly true, although its antagonism to Na is much less marked, as the results given below show.

After	24	24	35	21	24	hours
in NaCl	.053125	.10625	.2125	.425	.85	per cent.
in $MgCl_2$	.0053125	.010625	.02125	.0425	.085	per cent.
there were	15	15	15	15	0	survivors.

Time of acclimatization 104 hours.
Average strength of preparatory solution in Na .199 per cent.
Average strength of preparatory solution in Mg .0199 per cent.

Comparison with the results with pure NaCl shows that the presence of the Mg enables the larva to withstand a solution of increasing concentration with average strength of .199 per cent. NaCl for 104 hours without a single death, whereas in the absence of Mg, 33 per cent. die in 101 hours. Both in the presence and absence of Mg, however, there were no survivors in the .85 per cent. solution after 24 hours, which shows that the Na–Mg antagonism is less pronounced than that between Na and Ca.

While these experiments give some insight into the conditions of survival for frog larvæ in sea water, the actual circumstances are probably not as simple as one might at first conclude, for granted an antagonistic action between Na and K, Na and Ca, and Na and Mg, it does not follow that in a solution in which all these salts are present, the total antagonistic effect toward Na could be represented by the formula, Na *vs.* (K + Ca + Mg) for ions capable of antagonizing the Na may antagonize each other. The existence of these "accessory" antagonisms has been demonstrated by Loeb and Wasteneys for *Fundulus*. In the case of the frog embryos I found an antagonistic action between Mg and Ca, for although both these ions antagonize the Na, yet a solution containing all three is a less

[3] *Biochemische Zeitschrift*, Bd. 31 and 32.

favorable one for the embryos than one containing only Na and Ca. The experiments on which this statement is based are tabulated below and can be compared with the earliei ones.

After	21	21	25	24	24	hours
in NaCl	.053125	.10625	.2125	.425	.85	per cent.
in $CaSO_4$	.0028125	.005625	.01125	.0225	.045	per cent.
in $MgCl_2$	.0053125	.010625	.02125	.0425	.085	per cent.
there were	15	15	15	15	12	survivors.

Time of acclimatization 120 hours.
Average strength of preparatory solution in Na .199 per cent.
Average strength of preparatory solution in Ca .0105 per cent.
Average strength of preparatory solution in Mg .0199 per cent.

Conclusion.—The ability of amphibian eggs to develop in sea water is dependent on the principle of ionic antagonism. In addition to this, however, their power of acclimatizaplays an important rôle, for it not only enables them to withstand the passage from dilute to strong solutions, but the opposite process as well. Thus larvæ which have just reached a point where they fail to react to tactile stimuli in solutions which do not bring about dehydration, either because the solutions are too weak, or because the larvæ have been acclimated, will if transferred to fresh or distilled water recover in from one to two hours. If in addition to this we remember that the species found by Pearse is probably racially acclimated to the conditions under which it lives, his findings do not appear inexplicable.

Otto Glaser
Zoological Laboratory,
University of Michigan,
July 15, 1912

THE SCALES OF DERMOPHIS

In Science, July 28, 1911, p. 127, I described the scales of the Asiatic amphibian *Ichthyophis,* pointing out their resemblance to certain fish scales. Early this year my wife and Mr. Earl Morris obtained a number of amphibians and reptiles at Quirigua, Guatemala,[1] and among them a specimen of the Cœciliid amphibian *Dermophis mexicanus* Peters. The scales of this animal are minute, oblong to suboval, superficially similar to those of *Ichthyophis.* The essential structure is also the same, but the cell-like areas, instead of being more or less brick-shaped, are long and narrow, usually pointed at the ends, as though compressed. The scales of *Ichthyophis* are finely granular, but *Dermophis* shows little of this. The structure of the *Dermophis* scale is even more like that of the eel *Synaphobranchus pinnatus* than is that of *Ichthyophis.*

On the whole, the correspondence in minute structure between the scales of the two Cœciliids examined, from opposite sides of the world, is very striking. It is evident that in the Cœciliids, as well as in the more primitive types of scaly fishes, scale-structure is extremely persistent. It is proper to say, however, that the two genera are otherwise rather close in structure, and it remains to be seen whether the scales of more divergent genera, such as *Cryptopsophis* or *Gymnophis,* present any marked differences.

T. D. A. Cockerell
University of Colorado

[1] These were very kindly determined for us by Dr. L. Stejneger. It may be worth while to give the list, as a contribution to the knowledge of their distribution: *Leptophis mexicanus* (Dum. & Bibr.), *Streptophorus atratus sebœ* (Dum. & Bibr.), *Ameiva undulata* Gray, *Bufo valliceps* Weigm., *Hyla baudinii* Dum. & Bibr., *Dermophis mexicanus* Peters, *Spelerpes* (? *rufescens* Cope, condition poor).

MINERAL CONTENT OF VOLANIC ASHES FROM KODIAK[1]

Following the recent eruption from Mount Katmai (the first week of June, 1912) samples of the volcanic débris falling near the Agri-

[1] Published by permission of the Secretary of Agriculture.

cultural Experiment Station in Kodiak were collected.[2] The samples here described were submitted to this bureau through the Office of Experiment Stations and a mineralogical examination of them was made.

Sample No. I. is light in color and rather coarse. It represents the first fall, which reached a depth of about six inches. There are present indeterminable feldspars, a slight amount of muscovite and a few apatite inclusions. Glass constitutes the larger part of the mass. The refractive index of this glass is below 1.50, thus indicating that the silica content is above 72.65 per cent.

Sample No. II. represents the second fall which reached about three or four inches in depth. It is reddish in color. The minerals present are hornblende, indeterminable feldspars, and biotite. Glass with the refractive index below 1.50 predominates. Some of the glass particles, however, had an index above 1.50. Obviously the material in the second fall is more basic than that of the first fall.

Sample No. III. represents the last fall, is light in color and very finely divided. Indeterminable feldspars, muscovite, and a few indeterminable particles of what appear to be some ferro-magnesian mineral are present. Glass with index below 1.50 predominates. Apparently the material in the last fall is between the first and second as regards basicity, *i. e.*, chemical composition.

These three mineralogical analyses indicate that the ashes were derived from a magma agreeing fairly well in composition with a granite magma. The silica content of three granites taken more or less at random from Washington[3] are as follows: (1) 72.48 per cent., (2) 76.91 per cent., (3) 74.40 per cent. The refractive index of the glass in these falls at Kodiak shows a silica percentage greater than 72.65, which makes the glass of the samples correspond very nearly in silica content with granite. The silica content of three obsidians, also taken from Washington, are as follows: (1) 75.52 per cent., (2) 76.68 per cent., (3) 76.20 per cent. These also agree fairly well with the silica content of the glassy part of the ash.

The analyses also indicate that a partial differentiation had taken place in the magma. Sample No. II. contains both hornblende and biotite which are not present in sample No. I. Moreover the index of some of the glass particles in No. II. indicates a lower silica content than is the case of the glass of the first and third falls.

As compared with ordinary soil material these falls are distinguished mainly by the high content of glass. There is every reason to anticipate that these glasses, as well as the definite minerals, would dissolve, hydrolize, and behave as would ordinary soil minerals. In fact the glasses would probably react with the soil water more rapidly than crystalline components of the soil.

No substances deleterious to plant growth were revealed by the examination, and on the whole these falls will probably serve ultimately as an enrichment of the preexisting soil, although it by no means follows that the immediate effects will be satisfactory.

William H. Fry

Bureau of Soils,
U. S. Department of Agriculture

[2] For a general description of this eruption see "Volcanoes of Alaska," *The National Geographic Magazine*, Vol. XXIII., p. 824, 1912.

[3] U. S. Geol. Surv., Professional Paper 14, 1903.

SOCIETIES AND ACADEMIES

THE AMERICAN MATHEMATICAL SOCIETY

The one hundred and sixtieth regular meeting of the American Mathematical Society was held at Columbia University on Saturday, October 26, extending through the usual morning and afternoon sessions. Fifty-two members were in attendance. Among those present were Professors Emile Borel, of the University of Paris, and Vito Volterra, of the University of Rome.

Vice-president Taber occupied the chair. The council announced the election of the following persons to membership in the society: Dr. Henry Blumberg, Brooklyn, N. Y.; Mr. J. M. Colaw, Monterey, Va.; Dr. F. M. Morgan, Dartmouth College; Dr. Louis O'Shaughnessy, University of Pennsylvania; Dr. C. T. Sullivan, McGill University.

Luncheon was served at the university. In the evening sixteen members gathered at the usual dinner.

The following papers were read at this meeting:

H. W. Reddick: "Systems of plane curves whose intrinsic equations are analogous to the intrinsic equation of an isothermal system."

L. L. Dines: "Note concerning a theorem on implicit functions."

L. L. Dines: "Singular points of space curves defined as the intersections of surfaces."

E. T. Bell: "On Liouville's theorems concerning certain numerical functions."

E. T. Bell: "The representation of a number as a sum of squares."

G. R. Clements: "Implicit functions defined by equations with vanishing Jacobian. Supplementary note."

Edward Kasner: "Note on contact transformations of space."

E. H. Taylor: "An extension of a theorem of Painlevé."

L. S. Dederick: "On the character of a transformation in the neighborhood of a point where its Jacobian vanishes."

Vito Volterra: "Some integral equations."

W. F. Osgood: "Proof of the existence of functions belonging to a given automorphic group."

G. D. Birkhoff: "Proof of Poincaré's geometric theorem."

E. V. Huntington: "A set of postulates for abstract geometry in terms of the simple relation of inclusion."

Dunham Jackson: "On the degree of convergence of related Fourier series."

A. A. Bennett: "Note on the solution of linear algebraic equations in positive numbers."

The San Francisco Section of the society held its regular fall meeting also on October 26 at the University of California. The regular meeting of the Southwestern Section will be held at the University of Kansas on November 30. The annual meeting of the society, including that of the Chicago Section, will be held at Cleveland, Ohio, December 31 to January 2.

F. N. Cole,
Secretary

THE BOTANICAL SOCIETY OF WASHINGTON

A special meeting of the society was held September 18, 1912, in honor of Professor Hugo de Vries, of the Hortus Botanicus, Amsterdam, who addressed the Society on "The Future of Plant Breeding as related to Agricultural Production." At the close of the address brief appreciative remarks were made by Professor W. M. Hays, Dr. E. F. Smith, Professor W. J. Spillman and Mr. F. V. Coville.

The 82d regular meeting was held at the Cosmos Club, Thursday, October 17, 1912, at 8:00 P.M., Mr. C. S. Scofield, president *pro tem.*, presiding. Nineteen members were present. Mr. W. H. Lamb, of the Forest Service, was elected to membership. The following papers were read:

The Cotton of the Hopi Indians: F. L. Lewton.

This paper will be published in full in Smithsonian Miscellaneous Collections, Vol. 60, No. 6.

A Botanical Trip to the Sevier Forest, Southern Utah: W. W. Eggleston.

Damping-off of Coniferous Seedlings: C. P. Hartley.

With the exception of the cedars, damping-off of seedlings is a serious hindrance to the raising of conifer seedlings. Surfacing beds with gravel tends to decrease the trouble. The disease is generally worst under moist conditions, but a well-drained nursery in dry climate in southwestern Kansas has suffered especially heavy loss from damping-off parasites. No positive control method has ever been developed for general use.

In western porous soils damping-off is simply a root-rot of very young seedlings, which may attack at any point from the ground surface to several inches below. Seedlings several weeks old may have the younger parts of their roots rotted and yet survive.

Pythium debaryanum appears to be the most dangerous parasite in western nurseries. *Rhizoctonia* sp., *Fusarium* sp., and probably *Trichoderma lignorum*, also cause damping-off. *Pythium* and *Rhizoctonia* have been successfully inoculated on autoclaved soil; but inoculations do not succeed uniformly on unsterilized soil, due probably to competition of bacteria and other fungi. *Rhizoctonia* loses parasitism in culture and different strains vary greatly in virulence.

All active *Pythium* in nursery soil can be killed very cheaply by means of fungicides. Heat, and fungicides which break down soon after application, such as mercuric chloride, or acids and copper salts followed by lime, are not effective in the west, because *Pythium* often reinfects such disinfected soil, running through it rapidly before seedlings raised on it develop resistance. This reinfection at least sometimes takes place through the air, and is difficult to prevent under nursery conditions. Excellent results have been obtained by treating beds before seeding with sulfuric acid and formalin, and on alkaline soils with zinc chloride and copper sulfate. These fungicides seem to leave a slight residue in the soil which protects reinfection. This protection sometimes fails. Rather complicated watering methods are necessary in the west to prevent chemical injury to the germinating seed by fungicides which leave residues. Further work is required to place any of the treatments on a firm economic basis.

The twelfth annual business meeting was held on Wednesday, October 30, 1912. Officers were elected as follows:

President—W. W. Stockberger.

Vice-president—C. R. Ball.

Recording Secretary—H. L. Shantz.

Corresponding Secretary—C. L. Shear.

Treasurer—F. L. Lewton.

The executive committee reported an active membership of 108.

W. W. Stockberger,
Corresponding Secretary

THE AMERICAN PHILOSOPHICAL SOCIETY

At the meeting of the American Philosophical Society, held October 4, 1912, a paper entitled "Some Tick-transmitted Diseases" was read by Professor G. H. F. Nuttall, M.D., Ph.D., Sc.D., F.R.S., of Cambridge, England. After referring to recent investigations dealing with the etiology of Rocky Mountain fever he gave a summary of our present knowledge of piroplasmosis in cattle, dogs, horses and sheep, and of certain differences exhibited by the parasites (*Piroplasma, Nuttallia, Thisleria*, etc.) causing the diseases grouped under the name of piroplasmosis. Spirochætal infections in man and animals were considered as well as the life cycle of the parasites (*Spirochœtes*) in the bodies of the ticks which convey them to the vertebrate host. The economic importance of tick-transmitted diseases was pointed out.

On Restorations of North and South American Tertiary Mammals: W. B. Scott.

The method of making restorations of the external appearance of extinct mammals was first discussed, and it was pointed out that the popular idea concerning the feasibility of restoring an extinct form from a few scattered bones was entirely erroneous. Only skeletons that are practically complete can be employed to advantage. Given such skeletons, it is not difficult to build up the muscles, and thus to determine with much accuracy the general form and proportions of the animal. The uncertain factors of hair and color-markings were then considered, and it was shown that a reasonable approximation to the truth may be reached even in these matters. Lantern slides of some forty unpublished restorations of mammals from the Tertiary of North and South America were exhibited.

The following is an abstract of an address on "Electrons," given before the society at Philadelphia on Friday, November 1, by Sir William Ramsay, K.C.B., F.R.S.:

The actual existence of electrons in motion has been conclusively demonstrated; the mass of an electron is not far from one 1830th of that of an atom of hydrogen; and as the mass of an atom of hydrogen is now known with fair accuracy, that of an electron is nearly 0.8×10^{-27} gram. Electrons in motion *are* negative electricity; they constitute a form of matter, which, at present, has more claim to the term "elementary" than have most of the "elements." Indeed, metals must be regarded as compound bodies, of which one component consists of one or more electrons; these electrons are, as a rule, not very firmly attached, as is evident from the generally easy oxidation of most metals. Non-metals are also composed partly of electrons, not so easily detached. The "combination of elements with each other" consists in the shifting of one or more electrons from the more metallic to the less metallic element; no doubt it will some day be possible to give "structural formulæ" to the elements, showing the relationship in position, or in directed motion, between the true elements, and their attached electrons.

The word "electricity" has a dual meaning; it may mean first an assembly of electrons, stationary or in motion; or second, waves in the ether, produced by the stopping or starting of electrons in motion. The motion of electrons constitutes one factor of electrical energy; wave-motion in the ether can be used as a means of generating electrical energy, by employing the waves in making electrons move.

Progress in man's command of natural forces has been made by learning how to direct and control the motion of masses—in other words, by acquiring a knowledge of mechanics; progress in the future will consist in acquiring the power to control and direct the motions of electrons. This has already been largely achieved by electric contrivances; it is, however, only by the use of concrete ideas regarding the "material" used, viz., electricity, that the progress of invention and discovery can be hastened.

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SOME PROBLEMS IN INFECTION AND ITS CONTROL[1]

I EXPERIENCE a high sense of honor on this occasion with which is mingled no less trepidation in view of the master in whose memory this lectureship was founded, and the great names that in the past have been linked with the post I am to-day asked to fill. I must believe that Huxley would have felt a deep interest in the theme which I have chosen to discuss before you and would have found in its intrinsic importance a compensation for any shortcoming that may appear in the presentation. For Huxley evinced a penetrating appreciation of that branch of biological science that has come to be called bacteriology, and as president of the British Association in 1870 devoted the occasion of his address to an illuminating examination of the doctrine of abiogenesis, or spontaneous generation, versus the doctrine of biogenesis or descent from living ancestors. This subject, long holding a merely academic interest, had become in the two decades immediately preceding the ground over which the conflict raged and out of which was to emerge the modern science of microbiology. While Huxley clearly pointed out that Redi in the seventeenth century and Spallanzani in the eighteenth had delivered the first telling blows that later, through Pasteur, led to the overwhelming defeat of the spontaneous generationists and the establishment on an indisputable basis of the extrinsic origin of the contagious and infectious diseases, he did not fail

[1] The Huxley lecture, delivered at Charing Cross Hospital School of Medicine, London, October 31, 1912.

to preserve in the discoveries just being made in reference to fermentation, putrefaction, and certain fungus and other diseases of insects, the herald of the new science that was to throw its protecting mantle not about man alone, but about all the higher animals and even about the plants, in order that the useful and indispensable should be protected from that inevitable contest in nature between higher and lower forms of life which constitutes disease and leads to premature decay and ruthless destruction.

Bacteriology has, up to now, distributed its favors unequally, but we must not be daunted by this circumstance. It has yielded, in some instances, knowledge of diseases of small, and withheld, in others, knowledge of diseases of great importance. In respect to the common and highly contagious diseases, measles and scarlet fever, for example, progress has been slight. A ray of hope has been cast upon this quest by the announcement[2] that measles can be caused in the monkey by inoculation of infected blood, but this awaits certain confirmation. Similar announcements have been made recently regarding scarlet fever.[3] Since a flood of knowledge has always suddenly flowed from the successful transmission of an obscure disease to the lower animals these reports have been viewed with eager expectation. In the case of scarlet fever I fear the expectation is not yet to be realized. We[4] spent last winter in the study of this subject and failed completely to infect or produce scarlet fever in a wide variety of lower monkeys. Possibly, but not certainly, the higher anthropoid ape, which is still less removed from the human species, is subject to inoculation.[5] The path of success in relation to the refractory diseases is marked by heavy obstacles, but it must be travelled none the less. How often indeed has crowning success come to the brave, thoughtful and adventurous when all but an expiring glimmer of hope had gone! Witness in this connection the sudden conquest of syphilis, in which the initial victory was won when it was ascertained that anthropoid apes can be infected experimentally. There followed in rapid succession the discovery of the causative spirocheta, the Wassermann clinical test and the fabulous drug, salvarsan, the usefulness of which outruns the wide bounds of syphilis itself.

But even after such a victory the drama had not come to an end. The spirochetal cause could now be discovered regularly where it had been as constantly missed before; doubts and disbeliefs in it were quickly yielding before the rapidly accumulating evidence; but the microorganism itself resisted all attempts at artificial cultivation. That the spirocheta is a parasite nicely adjusted to living tissues was clear from the difficulties surrounding the experimental inoculation of animals. Now this act also has been played.[6] The pallida has yielded to artificial culture by Noguchi and the method sufficing for it has suddenly exposed the whole class of disease-producing spirochetæ and some innocent species as well, to cultivation and ex-

[2] Anderson and Goldberger, *Bulletin of the U. S. Public Health and Marine Hospital Service*, 1911, No. 62.

[3] Cantacuzène, *Comptes rendus de la Société de biologie*, 1911, LXX., 403. Bernhardt, *Deutsche medizinische Wochenschrift*, 1911, XXXVII., 791, 1062; *Centralblatt für Bakteriologie, Parasitenkunde und Infectionskrankheiten*, Abteilung 1, Referate, Supplement, 1911, I., 27.

[4] Draper, George, unpublished studies.

[5] Landsteiner, Levaditi, and Prasek, *Annales de l'Institut Pasteur*, 1911, XXV., 754.

[6] Noguchi, *Journal of Experimental Medicine*, 1911, XIV., 99; 1912, XV., 90; 1911, XIV., 557; 1912, XVI., 199.

ploitation under laboratory conditions. It is obvious that the more nicely a parasitic organism is adjusted to its host the more difficult it will be to cultivate it outside the host and the more quickly it will lose in culture its pathogenic power. The pallidum, which for so long resisted the efforts to transmit it artificially to animals and then to cultivate it outside *in vitro,* loses after a few generations, as was to be expected, its disease-producing virulence, while the blood parasites of relapsing and tick fevers in man and spirillosis in fowls, which are strictly parasitic and pass a stage of their life in biting insects, retain this power for many generations. In turn, the culture of the pallida has yielded luetin which by causing a local allergic or hypersensitive skin reaction has provided clinical medicine with a new means of detecting latent luetic infection.

With this introduction to the more general theme of the hour I shall invite you to follow with me somewhat minutely the biological investigations of a disease that is still claiming the absorbed attention of both physicians and people, namely, poliomyelitis, or infantile paralysis. The disease has just been making the rounds of the world, coming as a very unwelcome intruder to many different countries. Until the present pandemic it was surrounded with mystery and fortified by superstition. It is the story of the working out of the natural history of poliomyelitis, now elucidated in many ways, that I propose to tell you. I have been led to choose this particular disease as my theme, both because it has claimed much of my attention during the past several years, and because it illustrates admirably certain general truths to which I desire to call your attention.

Poliomyelitis has been endemic in northern Europe for many years, but it is only five years since it started on that unique, and as yet unexplained, movement that has carried it around the globe. In America there is no previous history of a general prevalence or epidemic, although local outbreaks of infantile paralysis have from time to time arisen. Some significance attaches to the fact that the first two foci of the present epidemic—I say present, because since 1907 the disease has prevailed severely each summer and autumn at some places in the United States and Canada—arose in the Atlantic coast cities and in the state of Minnesota in the middle west. The former receive the mass of emigrant population from Europe, and the latter, secondarily, the large contingent of Scandinavian emigrants. The imposition of the infection upon America can thus be accounted for; but no explanation is afforded of the many years of immunity while Scandinavians were constantly arriving, and for the penetration of the disease to other European countries and to far distant parts of the world. However, within the pandemic period the disease has taken on new activity in Norway and Sweden, and as recently as 1911 the latter country has suffered a severe visitation.

On clinical grounds Scandinavian observers[7] had recognized the essentially infectious nature of poliomyelitis and had followed the evolution of the outbreaks and traced the connection between many of the cases. They became the defenders of the notion of human carriage, and by establishing certain unusual clinical forms of the disease—such as meningeal and abortive—placed this idea on firm ground. The notion was further extended to include healthy carriers of the infection who act as intermediaries between the actively ill and the new victims of infection. These

[7] Wickman, "Beiträge zur Kenntnis der Heine-Medinschen Krankheit," Berlin, 1907.

views have all alike been treated with more or less scepticism by the medical profession; in how far they have come to be supported by later acquisitions of knowledge will appear.

Apart then from these deductions, disputed and disputable, because not supported by certain tests, five years ago the mystery of the disease was wholly unfathomed. The outlook was suddenly brightened when Landsteiner and Popper in 1909[8] announced the successful transmission of poliomyelitis to monkeys, but the high hopes raised were as quickly dampened by the failure to propagate the experimental disease beyond the first generation. This obstacle was immediately removed when intracerebral was substituted for intraperitoneal inoculation, as was done by Lewis and myself[9] and by Landsteiner and Levaditi.[10] By this means the disease could be and has been transmitted through an indefinite number of monkeys. The inoculating matter is, first, the sterile spinal cord of a fatal human case, and, afterwards, the spinal cord of paralyzed monkeys.

The choice of the intracerebral route as superior to the intraperitoneal was not haphazard. All the severe effects of poliomyelitis are inflicted on the nervous system, and upon reflection this fact at once suggested that the parasitic cause of the disease must find favorable conditions for multiplication within the nervous tissues. When the material carrying the germ is put first into the peritoneal cavity it must traverse the blood before it can reach the nervous system, and the blood, as we know, has the power to destroy many forms of germ life. It could, of course, also be reasoned that the specific parasite, in nature, can not enter the nervous tissues directly but must use some external route to reach them, and it must, therefore, be capable of surviving outside the brain and spinal cord; and it could be further reasoned that an inoculation into a more accessible part of the body than the brain and spinal cord should be effective, and if effective would bring stronger proof of the actual existence of a parasite in the inoculated matter. This reasoning is unconvincing for two causes: first, the monkey is not naturally subject to poliomyelitis and is, therefore, presumably more difficult to infect at all than is man so that what may suffice to cause infection in man may fail in the monkey; and, second, it might be possible for pathogenic microbes to reach the central nervous system even in man without entering the blood at all so that in nature the infectious cause of poliomyelitis might avoid the blood altogether. That this possibility really exists has been proved by experiment, as we shall see. Doubtless the first material inoculated into the abdominal cavity carried besides the living parasites toxic or other injurious substances that promoted infection in the monkey; but when the nervous tissues of the monkey were similarly injected, being less harmful, the inoculation failed. Bacteriology contains many instances of similar, and apparently of paradoxical nature.

The discrepancy has been further elucidated, as will soon appear, but in the meantime it is desirable to inquire whether

[8] Landsteiner and Popper, *Zeitschrift für Immunitätsforschung, Originale*, 1909, II., 377.

[9] Flexner and Lewis, *Journal of the American Medical Association*, 1909, LIII., 1639; *Journal of Experimental Medicine*, 1910, XII., 227. Flexner, *Journal of the American Medical Association*, 1910, LV., 1105. Flexner and Clark, *Journal of the American Medical Association*, 1911, LVII., 1685. Howard and Clark, *Journal of Experimental Medicine*, 1912, XVI., 850.

[10] For a general bibliography, see Römer, "Die epidemische Kinderlähmung" (Heine-Medinsche Krankheit), Berlin, 1911.

still other routes of infection exist for the monkey. Since nervous tissue is favorable to the parasite it was injected into large nerves—such as the sciatic—in order to ascertain whether these furnished a suitable medium of propagation. The parasite grows along the nerve until the spinal cord is reached and produces injury of the cord first at the point of entrance before it extends to and attacks other parts. The injection into the nerve causes no paralysis but paralysis of the innervated muscles appears after the lapse of a time sufficient for the necessary multiplication of the parasite and its passage into the spinal cord.

Meanwhile the inoculated monkey shows no other signs of illness, and no other organ is severely affected; the injury is centered upon the nervous tissues. And not only does the parasite grow or flow along the nerve but it ascends along the spinal cord from lower to higher levels and eventually reaches the medulla and brain. At last the centers governing respiration are involved and death by paralysis ensues.

We have now been able to arrive at several important conclusions. The monkey can be made regularly to develop an experimental disease agreeing in all essential respects with poliomyelitis in man. Inoculation is necessary since keeping healthy and paralyzed monkeys together does not lead to infection. The parasitic cause of the disease can traverse the blood, in the monkey, to reach the central nervous organs, but with difficulty, while it easily traverses the peripheral nerves. That the natural, spontaneous disease, so called, in man and the induced disease in monkeys are very much alike is further shown by microscopic study of the spinal cord and brain which exhibit changes that are identical.

The pathological effects are of two kinds: injury to nerve cells not in the anterior gray matter alone but in the posterior gray matter of the spinal cord and in the intervertebral ganglia, medulla and brain; and cellular invasion of the pia-arachnoidal membrane of the spinal cord and medulla that follow the blood vessels into these parts and pass into the adjacent gray and white matter. The altered vessels permit an escape of albuminous fluid and blood cells into the meshes of the membrane where they mingle with the cerebrospinal liquid, and into the spaces in the tissue composing the solid white and gray matter. Sometimes the nerve cells, sometimes the meninges, vessels and supporting tissues suffer most. When the nerve cells are extensively injured the paralysis is marked; when the meninges are much affected, the symptoms are like those of meningitis. The virus of poliomyelitis displays a high affinity for nervous tissues, but it is the wide involvement of the nutritive vascular system in the pathological process that subjects the sensitive nerve cells to so high a degree of injury and destruction.

The microscopical conditions we observed in the course of our experiments were suggestive of two things: first, the nature of the parasite itself, and, second, the process of generation of the effects or lesions themselves. Up to this time no definite parasite could be detected in the nervous tissues either in human beings or monkeys, nor was anything of the kind found in the blood or other organs. The scarcity of polynuclear leucocytes in the altered cerebrospinal liquid and spinal cord itself spoke against a simple bacterial parasite. The large number of mononuclear cells spoke rather for a protozoal parasite. Neither could be found, although the most varied methods of staining and cultivation were employed. There remained the possibility of the parasite being invisible or ultramicroscopic and filterable. This it proved to be, for when a portion of the spinal cord of a recently paralyzed monkey was made into an emulsion with sterile distilled water, or simple saline solution, and then centrifugalized to remove the coarse suspended matter and afterwards pressed through a Berkefeld earthenware filter, which excludes ordinary cells, bacteria and protozoa, the clear liquid resulting was still capable of transmitting the disease. The activity of the filtrate is very great, since a fraction of a cubic centimeter still suffices to cause paralysis and death. The only distinction to be noted between the action of corresponding amounts of the emulsion and filtered fluid is that the former acts more quickly, as would be expected from the fact that it contains a greater number of the invisible organisms. This difference is soon compensated by the multiplication of those in the filtrate so that the end result is the same. By employing somewhat greater quantities of the filtrate for inoculation the incubation period of the disease can be made the same as that following the use of the emulsion. The disparity is strictly a quantitative one, since the filters retain a part of the minute organisms in their pores and thus reduce the number escaping with the filtrate. The greater the quantity of protein matter present in the fluid the fewer the parasites that pass the filter, and merely because the large protein molecules themselves tend to be held in the pores and thus render them impervious for the minute organisms. For this reason, also, fluids containing small numbers of the filterable parasites, but still sufficient to cause infection in the crude state, may fail, when filtered, to produce disease merely because those retained by the filter so far reduce the numbers as to bring them below the surely infecting dose. This reduction sometimes leads to another effect; namely, the slight degree of infection that forms the starting point of active immunization. By building upon such a beginning a high and enduring state of immunity has been achieved.

The first filterable parasite was discovered by Loeffler fourteen years ago, in the fluid lymph obtained from the vesicles of cattle suffering from foot and mouth disease. At the present time eighteen diseases are known that are believed on good ground to be caused by this class of minute living organisms. One alone among them is on the verge of visibility—the parasite causing pleuropneumonia of cattle. It alone has certainly been obtained in artificial culture. The methods of artificial cultivation need still to be worked out; and once they are discovered it is a safe prediction that control over the diseases produced by ultra-microscopic parasites will be quickly increased. The degree of infectivity of certain of the parasites—or viruses, as they are also called—is almost fabulous. One thousandth of a cubic centimeter of a filtered 2.5 per cent. suspension of a spinal cord of a paralyzed monkey suffices to cause infection and paralysis in another monkey; 0.020 of a cubic centimeter of infected lymph suffices to produce foot and mouth disease in a healthy calf, and the blood of fowl suffering from chicken plague is still active after being diluted 1,000 million times with water.

Three affections of human beings are contained among the eighteen diseases caused by filterable viruses: They are yellow fever, dengue and poliomyelitis. With one exception, the mosaic disease of tobacco, the remaining fourteen are maladies of domestic animals and include among them foot and mouth disease, horse-sickness, cattle-plague, sheep-pox, rabies, vaccinia, hog-cholera and chicken-plague. We can at present form no reliable conception of the biology of this class of parasite, although the virus of pleuropneumonia shows affinities with the bacteria, while that of yellow fever that passes a stage of its existence in mosquitoes probably belongs to the protozoa. It should be remembered that we possess no criterion of their presence other than the power to produce infection. Probably the list of these pathogenic parasites would be increased if methods were known for testing their symbiotic relations or cooperative effects with the usual bacteria and protozoa. Rous's[11] discovery of a filterable agent that causes sarcomatous tumors in the fowl has opened up new fields to exploration. We can make a rough guess as to their sizes since some pass through thick filters, the pores of which are smallest, while others pass the more porous filters with larger interstices only. Were the viruses as large as one fifth the size of the influenza bacillus, they would be beyond visibility with the most powerful optical system of the modern microscope. The dark-field microscope and the instrument devised for employing, for photographic purposes, the ultraviolet rays of the spectrum, that has doubled the potential power of the microscope, have failed to bring them into view. On the whole they resist drying well and show considerable resistance to disinfecting agents.

The ultramicroscopic viruses employ no single means of effecting entrance into the body. Some utilize insects to inject them into the blood. Mosquitoes inoculate the parasites of yellow fever and of dengue in man, and the virus of horse-sickness among animals; while flies inject the virus of parrot-fever; and worms and other insects, through close contact with infected and then with uninfected tobacco plants, disseminate the parasite of mosaic disease. The viruses of rabies, vaccinia and fowl-pox gain entrance through skin wounds, those of hog-cholera, foot and mouth disease and chicken-plague, by swallowing, while the parasites of variola and of pleuropneumonia are inhaled with air. These are the main avenues but not the sole routes of infection, since viruses that ordinarily enter the body by the respiratory mucous membrane may occasionally enter through a skin abrasion, etc.

It is significant that upon recovery from this class of infections a high and enduring degree of immunity is left behind. We have no knowledge of toxic substances, in the common sense, being produced by the filterable viruses, and therefore know nothing of the formation of antitoxins or bodies that neutralize poisons. The principles upon which the immunity depends appear to be chiefly microbicidal or substances that act directly upon the living parasites and destroy them. In some instances it has been possible to produce an actively immune state without at the same time causing severe disease, by employing for inoculation modified and weakened viruses and viruses combined with immune sera carrying the corresponding microbicidal substances. Once a certain active immunity is obtained it can be heightened by repeated injections of more active materials until a high degree is achieved. In the same manner immune animals that have recovered from disease are capable of having this immunity reinforced by subsequent injections of the active virus. Blood taken from the immune animals has been employed in practise in two ways: to protect for a brief period exposed animals from acquiring infection, and to bring

[11] Rous, *Journal of Experimental Medicine*, 1911, XIII., 397; *Journal of the American Medical Association*, 1911, LVI., 198.

about an actively immune state through inoculation with adjusted mixtures of virus and corresponding immune serum. The injection of viruses into animals not themselves subject to infection has, in a few instances, yielded immune sera. In this way a serum for foot and mouth disease has been prepared in the horse. Speaking generally, homologous sera are more active than heterologous, or, in other words, an immune cattle serum will act better in cattle than will immune horse serum; but curative sera in a real sense have not yet been produced for this class of diseases.

It is of great interest to determine the correspondence between the general data I have just reviewed and the special facts of poliomyelitis which have been shown to arise in consequence of an invasion of the nervous tissue by an ultramicroscopic or filterable virus. We may proceed to check off rapidly the main facts. The virus stands midway in point of size between the finest and coarsest examples. It passes readily through the more coarse and slightly through the finest filters. It is highly resistant to drying, and to light and chemical action. In dust, especially within protein matter, it survives weeks and months; in diffuse daylight indefinitely, and resists the action of pure glycerine and carbolic acid in 0.5 per cent. solution for many months. When animal tissues containing the virus suffer softening and disintegration or disorganization by mould, the virus survives. Recovery from poliomyelitis in man and the monkey is attended and produced by an immunization of the body. During this process microbicidal substances appear in the blood that are capable of neutralizing the active virus. This acquired immunity has, in the monkey, been reinforced by subsequent injection of large quantities of the living virus. Active immunity can be achieved by first injecting minute and later large amounts of the virus, and an adjusted mixture of immune serum and active virus will confer a beginning low active immunity capable of being heightened. Certain alien large animals, among which the horse and sheep are especially worth mentioning, are subject to immunization through injections of emulsions of the spinal cord and brain of paralyzed monkeys, and can thus be made to yield sera possessing microbicidal power and capable of conferring, as do human and monkey immune sera, a degree of passive immunity. Thus far no immunizing effect has been accomplished with the dead virus. Unless some growth and multiplication take place no immunity arises.

These facts show a close correspondence between the properties of the virus of poliomyelitis and those of the ultramicroscopic organisms in general. There remain to be considered the data bearing upon the manner of entrance of the poliomyelitic virus into the body or, in other words, upon the mode of infection. Analogy with other diseases produced by filterable viruses excludes no one of the possible modes, since their manner of entrance is widely varied, as we have seen. This question is of the utmost importance, since with all diseases prevention is far better than the most perfect cure, and for poliomyelitis there exists at present no specific or true curative treatment. Moreover, for the most part when the disease is first recognized it has already caused irreparable damage, and though the more general examination of the spinal fluid obtained by means of lumbar puncture for purposes of diagnosis may possibly lead to a much earlier recognition of the disease, yet its prevention will always remain the result to be aimed at. It is quite certain that an understanding of the mode of infection would lead inevitably to the framing of measures of prevention that with reasonable certainty could be expected to exercise control over the epidemic spread.

Two answers may be returned to the question: one based upon observation of human cases of poliomyelitis, and the other based upon experimental tests arranged to elicit specific replies. The first answer can not achieve anything higher than strong probability; the second, to be valid, must explain the phenomena attending the human infection as well as those of the experimental disease. We are asked to account for certain data, of which the following is a brief statement. Epidemic poliomyelitis is preeminently a disease of early childhood and finds the highest percentage of its victims in the first five years of life, but does not wholly spare older children or even adults. It is admittedly infectious; and while it is true that many more instances of single than of multiple cases occur, yet multiple ones are not by any means rare. The prevailing views on this topic are being modified rapidly by the recognition of the abortive and ambulant examples of the disease. The period of greatest prevalence is during the months of August, September and October in the northern hemisphere, and the corresponding months in the southern hemisphere, but the epidemic begins in the early spring and summer months and the disease does not wholly disappear during the winter months. It does not, therefore, necessarily die out at any period of the year. In endeavoring to trace the avenue of entrance of the virus into the body certain facts regarding its distribution in the body should be recapitulated and considered.

The infectious agent of poliomyelitis attacks chiefly the central nervous system. Indeed, it has been detected regularly in the spinal cord and brain and in the mesenteric lymph nodes among all the internal organs. It has also been detected in the mucous membrane of the nose and throat, and in the mucus secretions of this membrane, and in the mucus secretions of the stomach, and the small and large intestine. The virus has not been detected in such important organs as the spleen, kidneys, liver or bone marrow. The fact is significant, but in attempting to interpret it, account should be taken of the circumstance that at present we possess one means only of detecting the virus, and that is its transmission to monkeys, in which it produces characteristic paralyses and anatomical changes. On this account small quantities of the virus may conceivably escape discovery. However, the conclusion is none the less inevitable that detectable amounts of the poliomyelitic virus exist only in the few situations and organs mentioned. The distribution of the virus is identical in human beings, the subjects of the so-called spontaneous poliomyelitis, and in monkeys, in which the experimental affection is produced. Nor does it matter how the experimental inoculation is accomplished and whether the virus is introduced by injection into the brain or large nerves or subcutaneous tissue or peritoneum, or whether it is merely applied to the nasal mucous membrane, which, it should be emphasized, next to direct intracerebral injection, affords the surest means of causing the experimental disease. In whatever way the infection is produced purposely, the distribution of the virus in infected monkeys is the same as in infected human beings.

The virus is one that is not known to increase aside from the infected body, and hence in order that it shall be capable of propagating poliomyelitis, it must secure a means of escape from the infected animal. The escape is now known to occur along with the secretions of the nose and throat, and the discharges from the intestine. We are obliged, therefore, to ask ourselves what the means are by which the virus confined within the interior reaches these external surfaces of the body.

Let us begin by disregarding for the moment the essential point of the way in which the virus probably enters the body in infected human beings, and give our attention to the way in which it escapes in the infected monkey into the nose, throat and intestines. We may first consider the instance in which the virus is deposited in the brain, in which it becomes sealed, as it were, and cut off apparently from the exterior of the body. Having been injected into the brain, the infectious microorganism constituting the virus multiplies both within and about the brain tissue at the site of inoculation. As multiplication progresses, the virus leaves the original site of injection and wanders through adjacent and distant parts of the central nervous tissues, becoming implanted in the medulla, the spinal cord and the intervertebral ganglia, as well as reaching the pia-arachnoidal membranes, or meninges, in which it also spreads. Ultimately, when the virus becomes sufficient in amount, it brings about anatomical changes in the nervous system, one of the results of which is paralysis. The period intervening between the inoculation and the appearance of paralytic symptoms may be as brief as two or three days, or as long as three, four or five weeks. The great disparity in this period depends upon the amount and quality of the virus, as well as the degree of resistance of the inoculated monkey.

The virus, which has found its way to the meninges, does not long remain in the cerebrospinal fluid, with which it escapes in part into the blood, where it does not appear to undergo any further increase in amount, and indeed seems even incapable of surviving for long. A part also of the virus contained within the cerebral fluid escapes regularly by way of the lymphatic channels surrounding the short nerves of smell that pass from the olfactory lobes of the brain to the mucous membrane of the nose. It has long been known that there is an intimate connection between the lymphatic vessels of the nasal mucous membrane and the lymphatic spaces of the pia-arachnoidal membrane. The virus once having gained the mucous membrane of the nose may even escape into the mucus secretion, with which it is carried into the mouth, and in part swallowed, or it may become established in the substance of the nasal membrane, where it undergoes subsequent multiplication and increase. As a matter of fact both these things occur. The virus escapes with the secretions partly externally to the infected body, and a part of it is swallowed with the secretions themselves, while a persistent infection of the secretions is maintained by means of the increase that takes place in the membrane itself. In this way is assured the escape of the virus directly into external nature, as well as the contamination of the gastro-intestinal cavity, with the discharges of which it becomes commingled. Once implanted upon the intestine multiplication not improbably continues for a time, and another source of invasion of the body is thus afforded the parasite. From the intestine it reaches in some amount the mesenteric lymph nodes, and thus enables us to account for the occurrence of the virus in those lymphatic nodes which thus form a notable exception to the general internal organs of the body.

We have now followed the route by which the poliomyelitic virus, implanted within the apparently closed cavity of the skull, reaches the exterior of the body. It is obvious that in the spontaneous form of the infection in man no such mode of introduction of the virus can occur. The virus must indeed enter the human body by some external channel, after which it seeks and becomes implanted upon the central nervous system. It is known that in monkeys the virus is incapable of passing the barrier of the unbroken or slightly abraded skin, of being taken up from the stomach or intestine unless the functions of these organs are previously disturbed and arrested by opium, and it is further known that it traverses with difficulty or even not at all the substance of the lungs. On the other hand, it is established that the virus passes with readiness and constancy from the intact or practically intact mucous membrane of the nose to the central nervous system.

To illustrate this point I wish to describe briefly an experiment. The spinal cord of a paralyzed monkey always contains the virus we are considering. If a camel's hair pencil or pledget of cotton is covered with some of the broken up tissue of such a cord and painted upon the mucous membrane of rhesus monkeys, these animals will develop in due time the paralysis and other symptoms of poliomyelitis. Hence the virus enters the body from this surface even though no gross injury has been inflicted upon the membrane. We should now ask ourselves if the virus actually ascends to the brain by the direct path of the olfactory nerves or indirectly after first entering the blood. This is the same question that has been buffeted about in regard to epidemic meningitis. The meningococcus is found in the nasal mucous membrane of persons in contact with cases of meningitis, and in the sick themselves. It is not disputed that the meningococci settle on this membrane, but opinion is divided as to whether it goes at once to the membranes of the brain or first penetrates into the blood. To produce meningitis in monkeys it does not suffice to inoculate the nasal membrane; the meningococci must be injected into the membranes themselves. But so inoculated they escape in part along the nerves of smell into the nose. The virus of poliomyelitis is so active that implantation in the nose does suffice to cause infection. If a monkey is sacrificed about forty-eight hours after an intranasal inoculation, and the brain and spinal cord are removed and then the olfactory lobes and portions of the medulla and spinal cord are separately inoculated into other monkeys, infection is produced by the olfactory lobes alone, since in this brief period the virus has not yet reached other and more distant parts of the nervous organs. Were the virus distributed by the blood, the medulla and spinal cord would have become infective, rather than the olfactory lobes, since they exhibit a greater selective affinity for the parasite. The conclusion, therefore, is unavoidable that the virus ascends by the nerves of smell to the brain, multiplies first in and about the olfactory lobes and, in time, passes, as I believe, into the cerebrospinal liquid which carries it to all parts of the nervous organs. We have already learned that the virus can pass along a large nerve, such as the sciatic, which carries it first to the lumbar cord, whence it ascends to higher levels; we need not, therefore, be astonished to find that it can wander along the olfactory nerves and then descend to lower levels. The large peripheral nerves are prevented anatomically from becoming infected in nature, while the small olfactory filaments are advantageously placed to act as the means of transportation. Hence the view I desire to place before you, that the nasal mucous membrane is the site both of ingress and egress of the virus of poliomyelitis in man. Support for this view is found also in the study of the microscopic changes in the meninges and the central nervous tissues. Since the virus survives in the dried state it may be carried in dust; and in one instance it has been detected in sweepings from the room occupied by a person ill with poliomyelitis.[12] Its distribution as spray in coughing and speaking is readily accomplished, and by this means both active cases and passive carriers may conceivably be produced. Still one link in the chain of causation of poliomyelitis as here outlined remained to be forged. The clinical evidence is strong in suggestion that human carriers of the poliomyelitic virus exist. The virus has now been detected in the secretions of the nose, throat and intestine of persons suffering from abortive or ambulant attacks of poliomyelitis.[13] The unrecognized examples of the abortive disease play a highly important part in the dissemination of the virus, through which the area of infection is extended, and the number of the attacked increased. A similar part has been accorded by clinical observation to the healthy virus carrier, and the healthy carrier is the last to be detected, and his existence confirmed experimentally. The obstacles in the way of this confirmation are considerable but not insuperable. It is to be remembered that we possess no means of discovering the virus except that of animal inoculation. Should the experimental results arising from the inoculation of the secretions of the nose and throat of such healthy carriers be confirmed the evidence for the mode of infection as here outlined would be complete. The membrane of the nose and throat is far more vulnerable in young individuals, whence arises the greater prevalence during childhood of those diseases the causes of which seek this avenue of entrance into the body. Among them are included diphtheria, measles, scarlet fever and meningitis.

Would the establishment of the respiratory avenue of entrance of the virus exclude all other modes of possible infection? By no means. Plague bacilli are known to be inoculated into man by rat fleas; but the pneumonic form of the plague is admittedly caused by respiratory inoculation. Diphtheria arises upon the mucous membrane of the throat, but can develop in a wound of the skin; the virus of smallpox enters by way of the throat and nose, but can enter by a skin abrasion; the virus of foot and mouth disease is taken in with food, but produces infection when injected into the skin. Hence at the moment while knowledge is still recent and not yet perfect the too absolute adherence to one point of view is to be avoided.

Indeed, the preponderance of cases in the late summer and autumn months early suggested an insect carrier of the infection. House flies can act as passive contaminators, since the virus survives upon the body and within the gullet of these insects. It has not proved possible thus far to infect the common varieties of mosquito and the body and head louse, while success has resulted in one instance in producing infection in bedbugs which were made to feed

[12] Neustaedter and Thro, *New York Medical Journal*, 1911, XCIV., 813.

[13] Kling, Wernstedt, and Pettersson, *Zeitschrift für Immunitätsforschung, Originale*, 1911–12, XII., 316.

upon the blood of inoculated monkeys. The virus remained alive within these insects for a period of many days. The inoculation of monkeys with a filtrate prepared from them gave rise to characteristic paralysis and anatomical lesions. This result is significant, since it shows that insects are capable of taking up the virus from the blood where it exists in minimal quantities and in harboring it for a considerable period in an active state; but it does not show that multiplication occurs within them or that in nature they act as the agents of inoculation. A tentative announcement has been made recently by Rosenau[14] that the stable fly (*Stomoxys calcitrans*) can take up the virus from the blood of infected monkeys and reinoculate it into healthy ones which will become paralyzed. The experiment awaits confirmation and, after confirmation, convincing application to the circumstances surrounding infection in human cases of poliomyelitis.

The frequent prevalence of epidemics in sparsely populated country districts has led, moreover, to consideration of domestic animals as sources of the infection. Paralysis of dogs, horses, pigs and fowl has been observed, not uncommonly, but thus far without clear correlation with paralysis in man. Perhaps the most frequently observed coincidental paralytic diseases have been between hens and human beings. Undoubtedly since the wide prevalence of epidemic poliomyelitis, the existence of a paralytic disease among barnyard fowl has been more commonly noted. Possibly the condition has not actually become more frequent, but owing to the circumstance mentioned it has been oftener observed. It appears that the paralysis among fowl is caused not by lesions of the central nervous system, but by lesions of the peripheral nerves and is due to a peripheral neuritis. It has not been found possible to transmit by direct inoculation the paralytic disease from chicken to chicken, or from chicken to monkey, or from paralytic monkey to chicken. However, it has been found possible to develop the paralysis in the laboratory by keeping the chickens in confinement for some time, and by supplying them an unusual and improper form of food. It has proved as little possible to transfer the paralytic affection of dogs from one individual to another by direct inoculation, or from dog to monkey, or from paralyzed monkey to dog, or to set up paralysis in monkeys by inoculating them with nervous tissue obtained from paralyzed pigs, or to produce paralysis in pigs with the virus of paralyzed monkeys. These failures do not, of course, exclude the possibility that a reservoir for the virus may exist among domesticated animals that do not even respond to its presence by developing paralysis or other conditions which could be recognized as resembling poliomyelitis in man. The manner of action of the virus of poliomyelitis in rabbits provides an illustration which shows how necessary it is to avoid general deductions in this field. At first it was strenuously denied that rabbits could be infected at all with the virus of poliomyelitis, and the examples of supposed successful inoculation reported were entirely disbelieved; but it must now be accepted that young rabbits occasionally, but by no means generally, are subject to inoculation with the virus of poliomyelitis, at least after it has passed through a long series of monkeys. Apparently a small percentage only of the inoculated rabbits develop any obvious symptoms, and these die, as a rule, during

[14] Rosenau, communication at the International Congress of Hygiene and Demography, Washington, 1912.

convulsive seizures which come on suddenly. A given virus has up to the present been sent through a series of six rabbits, after which it has failed to be further propagated. From the sixth series it has been reimplanted on the monkey, in which animal typical paralysis has been produced. It remains to add that the rabbits which succumb to the inoculation do not show any characteristic alterations of the central nervous system or other organs, as far as has been determined. The monkey, on the other hand, invariably shows the typical lesion of the central nervous system.

Long before epidemic poliomyelitis had the wide distribution or claimed the attention now accorded it, instances of infantile paralysis were known to every one. Almost every community could point to one or more examples of the condition and no one entertained the suspicion that the cause of the paralysis was an infectious or even contagious disease. Are these isolated cases of paralysis occurring among infants of the same nature as the epidemic paralysis, or has there merely been a confusion of names? We possess means that permit an answer to this important question. Recovery, as you recall, is associated with enduring immunity and the person or animal immune to poliomyelitis carries in his blood principles that neutralize the virus causing the disease. The blood of normal persons or animals lacks this property in any real degree. The test is, therefore, easily made: a mixture of the serum of the blood and virus are prepared, and after being in contact for a time is injected into a monkey. Thus it has been determined that the two diseases are caused by the same parasite, and it has been found that the neutralizing principles are still present as long as twenty-five years after the attack of paralysis and doubtless persist through life. This test has been employed likewise to identify abortive cases of poliomyelitis in which paralysis has not appeared at all.

There is nothing unique in this apparently paradoxical situation. Most, if not all, epidemic diseases prevail at some time as sporadic affections; that is, as diseases of occasional occurrence. This is true of influenza, plague and particularly of meningitis, with which poliomyelitis displays so many affinities. Knowledge is still very imperfect as to just what happens when an epidemic spread of a sporadic disease takes place. Sometimes conditions arise that favor rapid transference of the infecting microbe from individual to individual through which a rise in virulence is accomplished very much as is done every day in the laboratory to enhance the potency of cultures. In respect to poliomyelitis, as seems also to be the case with meningitis, a fresh importation of an already enhanced virus probably occurs and is the immediate cause of the epidemic. The introduction may be at one point or at several points simultaneously, according to where the epidemic arises, and spreads from a single center or from many foci. Finally, sports, or abnormally virulent parasites, appear, prevail actively for a period and then become reduced to an average degree of intensity perhaps never to rise again. Some of the exceptionally severe epidemics of which history tells us may be thus accounted for. Such sports have been encountered in laboratories in regard to both pathogenic bacteria and protozoa.

Are biologically different strains of a poliomyelitic virus known? The evidence at hand is to the effect that different strains or races certainly exist if virulence be taken as the measure. German, Austrian and French pathologists found that of the human specimens of spinal cords submitted to them for study about one half could be inoculated successfully into monkeys and less than this number could be propagated through successive animals. In America all the original specimens were successfully inoculated, but certain samples were far less active than others. At the beginning many of the inoculated monkeys survived the infection, sometimes with, sometimes without enduring paralysis of leg or arm. Later, fewer survived, and after many passages of the virus from monkey to monkey all became infected and all succumbed. The Swedish virus of 1911 appears to be the most powerful yet studied. This is indicated by the fact that saline washings of the nose and throat and intestine could be inoculated successfully, after removal of all bacteria through filtration, in nearly every instance.[15] In America it has been difficult to procure infection with these materials, from which it has been concluded that the virus displays a degree of infectiousness for monkeys. There are reasons for supposing that similar variations exist for man.

We may not, and probably shall not know certainly whether this variability is restricted to the quality of virulence or whether true types or races of the virus exist until artificial cultivation has been accomplished. Bacteriology has been singularly enriched recently by discoveries relating to biological types of certain microbes; and practical medicine is destined to benefit largely by the strong light which they have thrown upon perplexing questions of specific therapeutics. I am tempted to lead you aside a little way into this subject just because it is so full of suggestion and promise, and not merely with promise, since the fruits of discovery are being already tasted.

[15] Kling, Wernstedt, and Pettersson, *loc. cit.*

The pneumococcus causes many kinds of inflammation and one typical disease that prevails everywhere, namely, acute lobar pneumonia. Not infrequently there attend the pneumonia, and sometimes there appear independently such inflammations as peritonitis, pleuritis and meningitis, caused also by the pneumococcus. Now pneumococci possess in common biological features regarded usually as sufficient to distinguish them; namely, form, staining properties, growth, virulence and solubility in bile salts. But they have another quality that serves to distinguish them more finely, revealing different types among apparently similar organisms. By testing pneumococci from many different sources against an immune serum prepared with a single kind of the coccus, it has been found that the cocci are not all alike but that a predominant type and several subsidiary types occur in nature.[16] Such a serum prepared with a given type of pneumococcus is neutralizing for that one alone, and for no other. The clinical reports on the antipneumococcus serum employed as a curative agent are contradictory, and one cause for this is now apparent.

Pneumococcus meningitis can be produced in monkeys by injecting subdurally, by lumbar puncture, a virulent culture of pneumococcus; it is invariably fatal. Antipneumococcus serum alone injected subdurally can change the outcome very little. But this infection is subject to combined chemo- and serum-therapy in which the chemical agent consists of sodium oleate that alone attacks and dissolves the pneumococcus. Acting separately, in the body, sodium oleate can accomplish little; it re-

[16] Neufeld and Händel, *Zeitschrift für Immunitätsforschung, Originale*, 1909, III., 159; *Arbeiten aus dem kaiserlichen Gesundheitsamte*, 1910, XXXIV., 293; *Berliner klinische Wochenschrift*, 1912, XLIX., 480.

quires the assistance of the immunity principles. Acting together the two agents quickly bring the infection under control and recovery follows. This happens even after the pneumococci have entered the blood stream and begun to multiply there. The effects of the soap and serum compound are, however, restricted to the type of pneumococcus represented by the immune serum in the mixture.[17] When the type of microorganism and serum differ absolutely no therapeutic action follows. This obstacle to the practical employment of this method of specific treatment will doubtless be reduced or even wholly set aside by preparing a true polyvalent immune serum that will represent not many cultures of the pneumococcus taken at random, but the several types or races occurring in nature. We already know the number to be few.

It has become the custom to speak of these types of microbes as resistant or "fast"; but the term is relative merely. The fact and degree of fastness will be revealed by the source of the test-serum. But within a given microbic species this quality of resistance may well appear against chemical bodies as well. Pneumococci, for example, vary in properties by gradual gradations in the direction of the streptococcus, which besides differing in still other biological properties chances not to dissolve in bile. The gradients of pneumococci approaching the streptococcus are progressively less acted upon by sodium oleate. The trypanosome of sleeping-sickness is less subject to the therapeutic action of certain organic arsenic compounds in some regions in Africa than in others. The antimeningitis serum suppresses the growth and multiplication of most meningococci, but not of all. This quality of fastness is not alone innate but can be developed artificially as a mutation, both against serum principles and chemical drugs and may persist. Infectious diseases showing a strong tendency to relapse in course of recovery are caused by microbes tending to flourish as races or types. Relapsing fevers that pass three or four exacerbations on the way to recovery are attributed to spirochetæ assuming a corresponding number of distinct forms. Infections tending to many relapses, of which lues is an example, are attributed to parasites capable of flourishing in many such types of which one part is innate and the other the result of mutations under the influence of curative serum or drug. Fortunately, there appears to be no parasite capable of performing indefinite mutations; and experience is teaching that the more precise, specific and vigorous the means employed to control infection, the smaller the risk of mutation and the greater the probability of suppression of the parasitic agent of disease.

In 1886 Theobald Smith[18] first clearly pointed out that the injection of dead bacteria conferred active immunity to subsequent inoculation with virulent materials. Now the employment of dead bacteria is widespread both for preventing and for healing disease. Wright[19] especially is to be credited with the general application of the method to therapeutics. While the limits of value of inoculation, as it is termed, are not yet defined and it promises, theoretically, more for the subacute and chronic than for the acute infections, I am inclined to the belief that to be really effective attention will need more and more

[17] Lamar, *Journal of Experimental Medicine*, 1911, XIII., 1; 1912, XVI., 581.

[18] Salmon and Smith, *Proceedings of the Biological Society of Washington*, 1884–86, III., 29.

[19] Wright, *Proceedings of the Royal Society of Medicine*, 1909–10, III., Supplement, 1.

to be accorded to the question of specific type in the infecting bacteria.

In pursuing the devious courses of infection, of which examples have just been given, the fact has emerged that the effectiveness of curative means will be determined not only by the intrinsic qualities of the parasites but also in a high degree by the manner of location and distribution of the parasites themselves within the infected host. Whether they have a general distribution throughout the blood and tissues or whether they are confined within an important organ or part may be the factor determining the ease with which they can be reached not only by the natural curative principles of the body but also by artificial curative agents introduced into the body.[20]

The parasite, struggling to survive, withdraws, at one time, into situations to which the curative substances gain access imperfectly and with difficulty, causing thereby local infections more or less cut off from the general circulation and the curative substances purveyed by the blood. This is the condition met with in focalized inflammation and in infections of specialized portions of the body, such as the great serous cavities that receive a modified and dilute lymph secretion carrying reduced quantities of the protective principles contained within the blood. The quality of lymph in the several serous cavities and in the various tissues is not the same, and the lowest limit of strength is reached by the cerebrospinal fluid that functions as the lymph of the brain and spinal cord. The exclusion of dissolved substances from the cerebrospinal liquid is a provision of great importance, but is not an unmixed good. For while it affords protection to the sensitive nervous tissues from injurious chemicals, it deprives them also of curative principles. Happily this deficiency has now been superseded by a method of direct local treatment by injections that has given excellent results in meningitis, but is now being employed in luetic affections of the meninges and central nervous organs with encouraging results.[21]

Remote as some of them may seem, the considerations to which I have called your attention have a bearing more or less vital upon the problem of a specific and effective treatment of poliomyelitis. Poliomyelitis is not a disease with a very high mortality; its chief terror lies in its appalling power to produce deformities. When death does occur it is not the result, as in many infections, of a process of poisoning that robs the patient of strength and consciousness before its imminence, but is caused solely by paralysis of the respiratory function, sometimes with merciful suddenness but often with painful slowness, without in any degree obscuring the consciousness of the suffocating victim until just before the end is reached. No more terrible tragedy can be witnessed.

I have already laid before you certain facts regarding immunity in poliomyelitis and it remains to be added that the employment for treatment of the immune serum, taken from monkeys or from human beings, exercises a definite if not very strong protective action upon inoculated monkeys. Either the disease is prevented altogether or its evolution is modified in such a manner as to diminish its severity. When the virus used for inoculation is highly adapted to the monkey and thus very virulent it is more difficult to control the result than when it departs less from the original human type and is less active.

[20] Flexner, Simon, *Boston Medical and Surgical Journal*, 1911, CLXV., 709; The Harben Lectures, *Journal of State Medicine*, 1912, XX., 130, 193, 257.

[21] Swift and Ellis, *New York Medical Journal*, 1912, XCVI., 53. Wechselmann, *Deutsche medizinische Wochenschrift*, 1912, XXXVIII., 1446.

The immune serum has thus far acted best when it was injected into the subdural space on several successive days. This is in conformity with the fact that however introduced into the body the virus establishes itself in communication with the cerebro-spinal liquid where it propagates for a time. Later the virus localizes in the nervous tissue itself and becomes accessible not from this liquid only but, probably, from the general blood also. The serum introduced into the subdural space soon escapes into the blood; and thus a double action is secured: on the one hand, it reaches the nervous tissue directly from the cerebrospinal liquid, and on the other indirectly with the blood. An immune horse serum at first gave disappointing results but latterly its employment by intramuscular injection has given more promise. But none of the sera mentioned can be regarded as having more than touched the fringe of the problem of a cure for the disease.

Such brilliant success has been recently recorded in respect to the specific chemical therapeutics of infection that an effort has been and still is being made to attack the problem from this quarter. Here also only a starting point has been secured and the subject merely opened to further experimentation. The point of departure, which we have adopted, is the drug hexamethylenamin (urotropin) which possesses a degree of antiseptic action in the body and is known to be secreted into the cerebrospinal liquid. When the drug is administered by mouth it can be detected by chemical tests in the liquid in a short time. When inoculation of virus and administration of the drug are begun together and the administration continued for some days afterward, the development of the paralysis is sometimes but not always averted. Hexamethylenamin lends itself to modifications by the addition of still other antiseptic groups to its molecule. We have tested a large number of such modifications and have found certain ones to exceed the original compound in protective power, and others to promote the onset of paralysis. This is the common story of drugs. None are wholly without some degree of injurious action upon the sensitive and vital organs of the body. But manipulative skill has already succeeded in eliminating the objectionable and improving the valuable features of certain drugs so that they exert their action but little upon the organs and severely upon the parasites when they become useful as therapeutic agents. This process may be called sundering the organotropic and parasitotropic effects. Whether this can be successfully accomplished with this class of compounds can not be predicted. But if not, the quest will be transferred to still other drugs. When it is accomplished the victory will be won. By whom will the victory be won, and when? Ours is the office of story-teller and not the vision of the prophet!

In giving Huxley to science the Charing Cross Hospital School of Medicine conferred a great benefit upon the world. In imbuing him with the ideals of biological science it performed an especial service for America. For in 1876 Huxley journeyed to Baltimore to deliver the address at the formal opening of the Johns Hopkins University, at which time he outlined in essence the plan of medical education which, twenty years later, was adopted and put into practise at the Johns Hopkins Medical School. The example of this wise foundation, inspired by Huxley, has acted far and wide throughout the United States as a regenerating force upon medical education.

Simon Flexner

FACULTY PARTICIPATION IN UNIVERSITY GOVERNMENT[1]

The present government of American universities and colleges is altogether anomalous. The president and trustees hold the reins of power and exercise supreme control, while the professors are legally in the position of employees of the corporation. In the best institutions, however, it should be explicitly recognized that the status of the professors is in practise a good deal better than could be claimed as a matter of mere legal right. In the first place, the professors hold office for life or during good behavior or till the arrival of the age for superannuation with a reasonable pension. And in the second place, in the best American universities all educational matters have been either formally or by tacit consent delegated by the trustees to the faculties for authorization and final disposition. The place of the faculty as the sole educational authority of the university may be considered established, even though in some reputable universities the board of trustees reserves the right of veto or revision. Certainly in Cornell University the supremacy of the faculty in all educational matters has been maintained for a score of years, and professorial tenure of office is permanent and secure. Furthermore, the right to absolute freedom of thought and speech for all members of the faculty has been vigorously asserted and constantly enjoyed.

It should, therefore, at the outset be candidly acknowledged that a professor who enjoys a life-tenure of office, who is absolutely free to think and speak and write what he believes to be the truth, and who is a member of a body which controls the educational administration of the university, is already in possession and enjoyment of the highest, best and most vital things which inhere in his calling and function. Yet while all this is true the professor may be dissatisfied with the other conditions under which he is compelled to do his work. And this is undoubtedly the case in America.

Compare the American professor with the scholars and scientists of Oxford and Cambridge. They are their own boards of trustees. The legal corporation of an Oxford or Cambridge college is composed of the head (president, master, or whatever other name may be given to him) and the fellows, who are the teachers of the institution; and this body fills all vacancies by cooptation. Again in the two universities with which these self-governing colleges are connected there is a similar exercise of authority by the professors, and if it is not so complete that is only because it is shared by the nonresident Masters of Arts.

Look again at a German university. The state furnishes the funds for its maintenance and development, but, subject to the very light touch of a minister of education, the government of the university is in the hands of the faculty.

What the American professor wants is the same status, the same authority, the same participation in the government of his university as his colleague in England, in Germany and in other European countries already enjoys. He chafes at being under a board of trustees which in his most critical moods he feels to be alien to the Republic of Science and Letters. Even in his kindliest moods he can not think that board representative of the university. For the university is an intellectual organization, composed essentially of devotees of knowledge—some investigating, some communicating, some acquiring—but all dedicated to the intellectual life. To this essential fact the American professor wants the gov-

[1] From the report to the trustees of Cornell University by President J. G. Schurman.

ernment of his university to conform. And he criticizes presidents and boards of trustees because under the existing plan of government they obstruct the realization of this ideal—nay, worse, actually set up and maintain an alien ideal, the ideal of a business corporation engaging professors as employees and controlling them by means of authority which is exercised either directly by "busybody trustees" or indirectly through delegation or usurpation by a "presidential boss."

What is needed in American universities to-day is a new application of the principle of representative government. The faculty is essentially the university; yet in the governing boards of American universities the faculty is without representation. The only ultimately satisfactory solution of the problem of the government of American universities is the concession to the professoriate of representation in the board of trustees or regents and these representatives of the intellectual, which is the real life of the university, must not be mere ornamental figures; they should be granted an active share in the routine administration of the institution.

How could such a reform be carried out in Cornell University?

The board of trustees of Cornell University is a genuinely representative body. That is, it represents everybody but the faculty. The state of New York is represented by the governor and other *ex-officio* trustees and also (since the recent amendment of the charter) by trustees appointed by the governor with the advice and consent of the senate. The alumni are represented by trustees whom they themselves elect, and in June last a woman was, happily, once more elected as one of the alumni trustees. And, apart from alumni and state, the general public is represented by the trustees—half of the entire body if the *ex-officio* trustees be not counted—whom the board itself elects presumably from citizens who are especially concerned for the promotion of higher education or who are particularly interested in Cornell University. The trustees thus elected by cooptation number three annually; and it is the custom to reelect these trustees when their term expires.

Now in case of the death or resignation of one of these cooptatively elected trustees, the board might, without any change in the charter, ask the professoriate to select a candidate for the vacant position and then formally elect the candidate thus recommended. This process might be repeated till the professors had designated one third of the trustees now elected by the board, and thereafter professorial representation might remain in that ratio.

For the purpose of such representation it would probably be wise and expedient to divide the professorial electorate into groups each of which should elect one trustee. Only full professors would have the suffrage as only full professors hold permanent appointments. The full professors in the graduate school might constitute one electoral group, to fill (say) the first trusteeship assigned to the professoriate. The second electoral group might be composed of the full professors of arts and of law, and the third of the full professors of science and of medicine (in Ithaca). The full professors in the two engineering colleges and in architecture would naturally form a fourth electoral group, and those in the two state colleges—agriculture and veterinary medicine—a fifth. The medical college in New York City would furnish the sixth electoral group, but the number of professors entitled to vote should perhaps be limited to those who give their entire time to the work of the institution or those who are heads of the more important departments.

This plan would give the professors a share in the government of the university through the voice and vote of their own elected representatives, who (unless an unalterable state law forbids) should preferably be members of the faculty. But this injection of professorial trustees into the board would be a somewhat slow process, if, as is here recommended, it took effect only when vacancies occurred by death or resignation in trusteeships now filled by cooptation of the Board. There is, however, another measure of relief which could and should be forthwith adopted, and which should continue in operation whether the privilege of representation in the board of trustees be conceded or denied to the professoriate.

While the faculties of the university control educational affairs they have, under the statutes, nothing to do with the appointment of teachers, the appropriation of funds, or other business vitally connected with the life and work of the institution or the standing and efficiency of the several departments. Here, again, it is true that practise is more considerate than theory or ordinance. For in case of appointments the president makes no nominations to the board without previous conference and practical agreement with the professors in the department or allied departments concerned. The time, however, has now arrived to codify this practise and establish it as a matter of professorial right. And at the same time the right of the professors to share in other ways in the government and administration of the faculties or colleges to which they belong, and so far as practicable of the entire university itself, needs to be specifically recognized and formally confirmed.

Towards this goal the university has been gradually tending for some years past. There may not have been a distinct consciousness of it in the general mind of the academic community, but there has been a vague yearning against a background of dissatisfaction and a foreground of hope. The situation will be brought to the consciousness of itself and crystallized in and through the idea and program of professorial participation in the management and control of the university.

The plan to be proposed has the fundamental merit of every salutary reform: it is the modification and extension of an idea and organization already in successful operation. Professors sit, deliberate and vote with the trustees in the administrative boards and councils (as they are called) which manage the affairs of the university library and of the medical college in New York. The professors are elected by their colleagues for a term of two or three years, and the trustees are similarly chosen by the board of trustees. Under the statute creating these councils they are merely advisory bodies whose resolutions come as recommendations to the board of trustees or to the executive committee, but in practise these recommendations of the men selected by the board and by the faculty to keep in intimate touch with the affairs of those great departments of the university and to dispose of them in the combined light of business and educational experience, are regarded by the board as expressions of the highest wisdom available under the circumstances and are regularly approved or, if not approved at once, merely referred back in special cases for further consideration in view of some new contingency or some unforeseen bearing upon the general policy of the university.

The council of the medical college in New York City consists of the president of the university, who is *ex-officio* chairman, three trustees elected by the board for a term of three years, and the dean of the medical faculty and two professors elected by that faculty, for a term of two years.

The president recommends that a council of substantially this type be as soon as possible established for every college in Cornell University (except the state colleges for which councils composed exclusively of trustees have already been organized). Whether the professorial members of the council outnumber, or are outnumbered by, the trustee members is not a matter of any consequence if only it be understood that this is a scheme devolving genuine responsibility upon the professors for the administration and government of their collegiate unit of the university. If these councils are in practise to be as independent of the executive committee, and even of the full board, as the medical college council in New York City, it will probably be found necessary to allocate annually fixed portions of the income of the university to the different colleges. And with the existing distribution of funds as basis this assignment should not be an impossible task.

This is a plan of partnership between trustees and professors for the government and administration of the university. It is not the German system, which has no board of trustees, nor the English system, in which the professors are the corporation, but it is a modification of the American system in which the trustees voluntarily invest the professors with a share of their own powers and functions (devolving on them corresponding responsibilities), and guarantee them the maximum of authority, independence and institutional control which seems compatible with the American idea of university organization and government.

To these councils would be assigned the duty of dealing with all business of every kind affecting the several colleges. Whatever business now comes before the executive committee or the board of trustees affecting Sibley College or the College of Arts and Sciences or any other college of the university would be taken up by the appropriate council and settled in the form of resolutions which would be sent to the trustees for final approval and ratification. In time the councils would undoubtedly be empowered by the board of trustees to dispose definitely of routine business and minor affairs reporting only their action to the trustees. But at the outset it seems wise to follow in this respect the example already established by the council of the medical college.

There are, however, two deviations which should be made from that model, if it is to be used in Ithaca, and which indeed experience shows may in time be advantageously adopted in New York. In the first place not only should the term of office of professorial members of the council be limited, but professors should be ineligible for more than one reelection. The object of this restriction is to keep the faculty in general in close touch with the council. And, in the second place, the president should be required (as he is not in the case of the medical college council) to submit all nominations for appointments to the council in order that they may be voted on and the record of the vote sent to the board of trustees. For the reform here discussed involves the surrender of power not only by the trustees but also by the president, the supreme object being to secure (by means of the representative system applied to faculties) effective professorial participation in the administration and government of the university.

The president recommends that the foregoing scheme for taking the professoriate into partnership with the trustees in the government and administration of the university by means of college councils composed of representatives of both be adopted by the board of trustees at the earliest practicable date. Some features of the scheme may need modification, but it will be easy to determine what changes are advisable after trustees and professors have got together in councils for the transaction of the business of the different collegiate units of the university.

A further step in the same direction should also be taken at the present time. Under the existing statutes the deans of the faculties of arts and sciences and of the graduate school are appointed by the board of trustees on the nomination of the president. The faculty has indeed some voice in the matter, for it votes on the nomination of the president and sends the record of its vote to the board of trustees. But the time has arrived when the right of the faculty to select its own chief officer should be recognized and confirmed. The president recommends that the statute be amended so as to invest the faculty with exclusive power in this regard. The faculty would of course report its action to the trustees.

J. G. SCHURMAN

THE CLEVELAND CONVOCATION WEEK MEETING

THE sixty-fourth meeting of the American Association for the Advancement of Science, and the eleventh of the "Convocation week" meetings, will be held in Cleveland from December 30, 1912, to January 4, 1913. The first general session of the association will be called to order at 10 A.M. on Monday, December 30, by the retiring president, Dr. Charles E. Bessey, who will introduce the president of the meeting, Dr. Edward C. Pickering. After addresses of welcome and a reply by President Pickering, announcements will be made by secretaries. The general session will then adjourn and the sections will be organized in their respective halls. Where sections have programs, the reading of papers will begin after organization and will be continued in the mornings and afternoons of the following days. The council will meet on Monday morning, December 30, and each morning, in the council room at 9 o'clock. On Monday evening, Dr. Bessey will give the address of the retiring president, on "Some of the Next Steps in Botanical Science," to be followed by a reception to members of the association and affiliated societies.

The addresses of retiring vice-presidents before the sections will be as follows:

Vice-president Frost, before the Section of Mathematics and Astronomy: "The Spectroscopic Determination of Stellar Velocities, considered practically."

Vice-president Millikan, before the Section of Physics: "Unitary Theories in Physics."

Vice-president Cameron, before the Section of Chemistry: "The Chemistry of the Soil."

Vice-president Shimek, before the Section of Geology and Geography: "Significance of the Pleistocene Mollusks."

Vice-president Nachtrieb, before the Section of Zoology: "Section F—Is it Worth While?"

Vice-president Newcombe, before the Section of Botany: "The Scope of State Natural Surveys."

Vice-president Ladd, before the Section of Anthropology and Psychology: "The Study of Man."

Vice-president Norton, before the Section of Social and Economic Science: "Comparative Measurements of the Changing Cost of Living."

Vice-president Thorndike, before the Section of Education: "Educational Diagnosis."

Vice-president Porter, before the Section of Physiology and Experimental Medicine: "On the Function of Individual Cells in Nerve Centers."

The full program of the meeting, which will include the programs of the affiliated societies, will be issued at the beginning of the meeting and will contain announcements of public lectures, presidential addresses before the different societies, discussions and arrangements for joint meetings, together with the times of dinners, smokers and other social functions.

Cleveland is in the territory of the Central Passenger Association. Legislative acts having reduced fares in this territory to the two cents a mile basis, the Central Passenger Association can not make a further reduction by authorizing the certificate plan. From western points special tourist fares may be obtained. The hotel headquarters of the American Association will be the Hotel Statler, recently opened, with a very large number of rooms, all having baths, at the rate of $2 a day. The hotels are all near the center of the city. Persons arriving by the New York Central lines (Lake Shore or Big Four roads) or by the Pennsylvania lines, may conveniently alight at the Union Station; street cars run from this station directly to the hotels. Those arriving by other roads should go to the city stations in order to reach the hotel district conveniently. Section K, the American Physiological Society, the American Society of Biological Chemists, the American Association of Anatomists and the Society for Pharmacology and Experimental Therapeutics will meet at the Western Reserve Medical College, which is within easy walking distance of any of the hotels named. All other sections and affiliated societies will meet at Adelbert College, Case School of Applied Science, or the Normal School, which provide abundant facilities, so that related societies can be conveniently grouped. With the exception of the Western Reserve Medical College, the buildings are all close together, so that it will be convenient to pass from the meetings of one section to those of another. These institutions are all situated about four miles east of the center of the city, on Euclid Avenue, between East 107th Street and East 115th Street. All Euclid Avenue street cars, going eastward, pass these institutions. The cars run about once a minute, and require from twenty to twenty-five minutes to go from the hotels to the colleges. The street car fare in Cleveland is three cents, with universal transfers. Luncheon will be served in one of the buildings where meetings are held, probably at the Normal School, and there are several restaurants and lunch-rooms in the vicinity of the colleges. It is thought that all attending the meetings can be conveniently served. The general headquarters will be in the main building of Adelbert College of Western Reserve University, where there will be writing and rest rooms with the usual conveniences; there will also be rest rooms in various other buildings.

There will be sent to each member of the American Association by mail, included with bill for annual dues, a white registration card bearing the name and address of the member printed thereon. It is requested that this card be brought to Cleveland by each member attending the meeting and filled in by him to indicate his Cleveland address, his section, his affiliated society connections, together with the names of visiting ladies accompanying him. After the above information has been noted on card by the member, the card should be presented to the registration clerk at the headquarters, main building, Adelbert College, in exchange for official program and member's identification button. This can be accomplished without delay and the waiting in line as at previous meetings will be avoided. Official receipts for dues are mailed to members on the same day that their payments reach the office of the permanent secretary. For their own comfort, members are urged to send their dues to the permanent secretary as far in advance of the meeting as possible. In this way they will receive their cards by mail at once and avoid the necessity of waiting in line to make payment at the meeting. Nominations to membership and letters relating to the general business of the association should be sent to the permanent secretary, Smithsonian Institution, Washington, D. C. It is strongly urged that each member should make an effort to secure the nomination of some desirable new member.

The local executive committee for the Cleveland meeting consists of Charles F. Brush, honorary chairman; Frank P. Whitman, chairman; Dayton C. Miller, secretary; Worcester R. Warner, chairman, finance committee; Miss Jean Dawson, Theodore M. Focke, Edward P. Hyde, Franklin T. Jones, Charles A. Marple, Robert L. Short, Albert W. Smith, Harry W. Springsteen, Olin F. Tower and Frederic C. Waite. The finance committee consists of Worcester R. Warner, chairman, Edward P. Hyde and J. Robert Crouse. For all matters relating to the local arrangements Dr. Dayton C. Miller, local secretary, Case School of Applied Science, Cleveland, Ohio, should be addressed.

Members of Sections A, B, F, G, H, K and L are referred to the following ruling of the council:

Resolved, That at the annual meetings of the Association each section shall prepare a program of general interest to scientific men, which shall occupy an afternoon session, or, if desired by the sectional committee, both morning and afternoon sessions of the same day. This program shall include the vice-presidential address.

Resolved, That, as it is the policy of the Association to avoid competition with programs presented before the special national societies, the sections are recommended to arrange no programs of special papers for the annual meetings: *Provided*, that the corresponding national society meets at the same time and place.

Members of Section C, D, E and I, by reason of there being no correlative affiliated society designated to meet at Cleveland, are requested to send to the respective section secretaries information concerning papers they may desire to submit for the Cleveland meeting.

The societies meeting at Cleveland during convocation week are as follows:

American Association of Anatomists.—Meets on Tuesday, Wednesday and Thursday, December 31 to January 2, in anatomical and histological laboratories, Western Reserve Medical School. Secretary, Dr. G. Carl Huber, University of Michigan, Ann Arbor, Mich.

American Anthropological Association.—Meets from Monday to Friday, December 30 to January 3. Joint session with American Folk-Lore Society and with Section H, A. A. A. S., for presidential address on Wednesday, January 1, at 2:30 P.M. Secretary, Dr. George Grant MacCurdy, Yale University Museum, New Haven, Conn.

Astronomical and Astrophysical Society of America.—Will meet on dates to be announced. Will hold joint session with Section A, A. A. A. S., on Tuesday, December 31, 1912. Secretary, Professor Philip Fox, Dearborn Observatory, Evanston, Ill.

American Society of Biological Chemists.—Meets on Monday, Tuesday and Wednesday, December 30 to January 1. Joint session with American Physiological Society on date to be announced. Secretary, Professor A. N. Richards, University of Pennsylvania, Philadelphia, Pa.

Botanical Society of America.—Meets Tuesday, Wednesday and Thursday, December 31 to January 2. Joint sessions with Section G, A. A. A. S., and American Phytopathological Society on dates to be announced. Secretary, Dr. George T. Moore, Missouri Botanical Garden, St. Louis, Mo.

Botanists of the Central States.—Will hold short business meeting on date to be announced. Secretary, Dr. Henry C. Cowles, University of Chicago, Chicago, Ill.

American Association of Economic Entomologists.—Meets Wednesday, Thursday and Friday, January 1 to 3. Secretary, Albert F. Burgess, Melrose Highlands, Mass.

Entomological Society of America.—Meets on Tuesday and Wednesday, December 31 and January 1. Public address on Wednesday, January 1, at 8 P.M. Secretary, Professor Alex. D. MacGillivray, 603 West Michigan Avenue, Urbana, Ill.

American Federation of Teachers of the Mathematical and the Natural Sciences.—Meets on Tuesday, December 31. Secretary, Dr. Eugene R. Smith, The Park School, Auchentoroly Terrace, Baltimore, Md.

American Folk-Lore Society.—Meets on dates to be announced. Joint session on Wednesday, January 1, with Section H, A. A. A. S., and American Anthropological Association. Secretary, Dr. Charles Peabody, Peabody Museum, Cambridge, Mass.

American Association of Official Horticultural Inspectors.—Meets on Thursday and Friday, January 2 and 3. Secretary, Professor T. B. Symons, College Park, Md.

Society for Horticultural Science.—Meets on Tuesday, December 31. Secretary, Professor C. P. Close, College Park, Md.

American Mathematical Society.—Meets on Tuesday, Wednesday and Thursday, December 31 to January 2. Joint session on Tuesday, December 31, with Section A (and probably Section B). Secretary, Professor F. N. Cole, 501 West 116th Street, New York City.

American Microscopical Society.—Meets on

Tuesday and Wednesday, December 31 and January 1. Joint sessions with Sections F and G, A. A. A. S., on dates to be announced. Secretary, Professor T. W. Galloway, James Millikin University, Decatur, Ill.

American Society of Naturalists.—Meets on Thursday, January 2. Will hold symposium on "Adaptation." Secretary, Dr. A. L. Treadwell, Vassar College, Poughkeepsie, N. Y.

American Nature-Study Society.—Meets on Monday and Tuesday, December 30 and 31. Will probably hold joint session with School Garden Association of America on date to be announced. Secretary, Professor Elliot R. Downing, University of Chicago, Chicago, Ill.

Society for Pharmacology and Experimental Therapeutics.—Meets on Monday and Tuesday, December 30 and 31. Secretary, Dr. John Auer, Rockefeller Institute for Medical Research, New York City.

American Physical Society.—Meets in joint sessions in charge of Section B, A. A. A. S., on dates to be announced. Secretary, Dr. Ernest Merritt, Cornell University, Ithaca, N. Y.

American Physiological Society.—Meets on Monday, Tuesday and Wednesday, December 30 to January 1, in physiological laboratory, Western Reserve Medical School. Joint session with Section K, A. A. A. S., on Wednesday, January 1. Secretary, Dr. A. J. Carlson, University of Chicago, Chicago, Ill.

American Psychological Association.—Meets on Monday, Tuesday and Wednesday, December 30 to January 1. Joint sessions with Sections F and L, A. A. A. S., on dates to be announced. Secretary, Professor W. V. Bingham, Dartmouth College, Hanover, N. H.

American Phytopathological Association.—Meets on Tuesday, Wednesday, Thursday and Friday, December 31 to January 3. Will hold joint sessions with Section G, A. A. A. S., and with the Botanical Society of America on dates to be announced. Secretary, Dr. C. L. Shear, U. S. Department of Agriculture, Washington, D. C.

School Garden Association of America.—Will hold joint session with American Nature-Study Society on date to be announced. Secretary, Dick J. Crosby, U. S. Department of Agriculture, Washington, D. C.

Association of Official Seed Analysts.—Will hold meetings on Thursday, January 2. Secretary, Edgar Brown, U. S. Department of Agriculture, Washington, D. C.

American Society of Zoologists.—Joint meeting of Eastern and Central Branches, on Monday, Tuesday and Wednesday, December 30 to January 1. Joint session with Section F, A. A. A. S., on date to be announced. Joint meeting with American Society of Naturalists on Thursday, January 2. Secretary in charge, Dr. Winterton C. Curtis, University of Missouri, Columbia, Mo. Secretary (Eastern Branch), Dr. John H. Gerould, Dartmouth College, Hanover, N. H.

Gamma Alpha Graduate Scientific Fraternity.—Will hold annual convention, council meeting and banquet on Tuesday, December 31, 1912. H. E. Howe, recorder, Ashland, Va.

Sigma Xi.—Will hold annual convention with banquet on date to be announced. H. T. Eddy, president, University of Minnesota, Minneapolis, Minn.

SCIENTIFIC NOTES AND NEWS

It is announced from Stockholm that the Nobel prize for chemistry has been divided between M. Grignard, of Nancy, and M. Sabattier, of Toulouse, and the prize in physics to Mr. Gustaf Dalen, head of the Stockholm Gas Company. The prize in literature has been awarded to Dr. Gerhart Hauptmann, of Berlin.

Dr. Alexis Carrel, of the Rockefeller Institute for Medical Research, who has been awarded the Nobel prize in medicine, was given a reception at the College of the City of New York, on November 16. Among those who made addresses in appreciation of his work were President Taft and M. Jusserand, the French ambassador.

Professor Charles S. Minot, of Harvard University, and Professor William M. Sloane, of Columbia University, gave their inaugural lectures at the University of Berlin, on October 31. The German emperor and the empress were present at the ceremony.

A banquet will be tendered to Dr. Theodore N. Gill, associate of the Smithsonian Institution, professor emeritus of George Washington University, and a founder of the Cosmos Club, at the Cosmos Club on December 13, as a token of esteem, in affectionate commemoration of the completion of the seventy-fifth year of his age and fifty-sixth year of publication of his contributions to knowledge.

The secretary of the interior has announced the appointment of Mr. David White as chief geologist of the United States Geological Survey to succeed Mr. Waldemar Lindgren, who leaves Washington to become Rogers professor of geology and head of the geological department of the Massachusetts Institute of Technology. Dr. F. L. Ransome succeeds Mr. Lindgren as chief of the section of economic geology of metalliferous deposits. Mr. Lindgren retains his position as one of the geologists of the survey. He will probably take up for the survey next summer the study of the Homestake mine, South Dakota, and has in view also some reconnaissance work in southwestern Arizona.

The General Education Board of 17 Battery Place, New York City, announces that Mr. Abraham Flexner has become a member of its staff. Mr. Flexner is the author of "The American College" (1908), and of the "Bulletins on Medical Education in the United States and Canada" (1910) and "Medical Education in Europe" (1912), issued by the Carnegie Foundation for the Advancement of Teaching.

M. Émile Boutroux, known for his contributions to philosophy, has been elected a member of the French Academy.

The gold medal for science of the Prussian government has been conferred on Dr. Walther Nernst, professor of chemistry at Berlin.

The Swedish Medical Society has conferred the Retzius gold medal on Dr. John Newport Langley, professor of physiology in the University of Cambridge, for his work on the nervous system.

The Weber-Parkes prize of 150 guineas and a silver medal, founded in 1895 by Sir Hermann Weber in memory of the late Dr. E. A. Parkes, and awarded every third year to the author of the best essay on tuberculosis, has been awarded by the Royal College of Physicians to Mr. J. A. D. Radcliffe, pathologist to the King Edward VII. Sanatorium, Midhurst.

Dr. Jacques Huber, director of the Goeldi Museum of Natural History and of the Botanical Garden of Pará, Brazil, has been visiting the scientific institutions of the United States.

Walter Sheldon Tower, associate professor of geography in the University of Chicago, has returned from a seven months' tour of investigation of the economic, geographic and commercial conditions of Chile, the Argentine Republic, Uruguay and Brazil.

Mr. D. W. Berky, magnetic observer of the department of terrestrial magnetism, Carnegie Institution of Washington, left Biskra, Algeria, on October 29 for a trans-Saharan trip to Timbuktu. Mr. Berky is accompanied by Mr. H. E. Sawyer, magnetic observer of the department, an interpreter and caravan party. The expedition will require from four to five months' time and it is expected much valuable magnetic data will be secured.

J. Paul Goode, associate professor of geography in the University of Chicago, has well advanced toward completion a series of wall maps for colleges and universities—an attempt to produce in America maps of as high quality as those of Germany.

Princeton University has inaugurated a course of public lectures by members of the faculty on "Some Aspects of the Rennaissance." The lectures include "Philosophy," by Professor Kemp-Smith; "Natural Science," by Professor Trowbridge, and "The Medieval Mind," by Dr. Stewart Paton.

Under the auspices of the department of geology of Columbia University an illustrated public lecture was given by Dr. Herman Le Roy Fairchild, professor of geology in the University of Rochester on "Glacial Geology of New York State," on November 12.

Professor C. F. Hodge, of Clark College, Worcester, Mass., addressed the Science Club of the University of Wisconsin on "Fly Extermination as a Problem in University Biology," on November 6, 1912.

Professor Robert A. Millikan, of the department of physics in the University of Chicago, who recently presented papers before the Deutsche Physikalische Gesellschaft in Berlin and the Dundee meeting of the British Association for the Advancement of Science, is to give the annual Sigma Xi address at the University of Kansas early in November and also an address before the Kansas State Teachers' Association in Topeka on the subject of "Recent Discoveries in Physics and Chemistry."

At the annual meeting of the Kansas Teachers' Association, held at Topeka, November 7 and 8, Professors David Eugene Smith and Maurice A. Bigelow, of Teachers College, Columbia University, delivered addresses, the former on "Teaching Mathematics," and the latter on "Biology as Applied Science."

The following non-resident lecturers in highway engineering at Columbia University have been appointed for the 1912–13 session: John A. Bensel, New York state engineer; William H. Connell, chief, Bureau of Highways and Street Cleaning, Philadelphia; Morris L. Cooke, director, Department of Public Works, Philadelphia; C. A. Crane, secretary, the General Contractors Association; W. W. Crosby, chief engineer to the Maryland Geological Survey and consulting engineer, Baltimore; Charles Henry Davis, president, National Highways Association; A. W. Dow, chemical and consulting paving engineer, New York City; Walter H. Fulweiler, engineer, Research Department, United Gas Improvement Company; John M. Goodell, editor-in-chief, *Engineering Record;* D. L. Hough, president, the United Engineering and Contracting Company; Arthur N. Johnson, state highway engineer of Illinois; Nelson P. Lewis, chief engineer, Board of Estimate and Apportionment, New York City; J. C. Nagle, professor of civil engineering and dean of the School of Engineering, Agricultural and Mechanical College of Texas; Harold Parker, first vice-president, Hassam Paving Company; H. B. Pullar, assistant manager and chief chemist, the American Asphaltum and Rubber Company; J. M. F. de Pulligny, ingénieur en chef des ponts et chaussées, et directeur, Mission Française d'Ingénieurs aux Etats-Unis; John R. Rablin, chief engineer, Massachusetts Metropolitan Park Commission; Clifford Richardson, consulting engineer, New York City; Philip P. Sharples, chief chemist, Barrett Manufacturing Company; Francis P. Smith, chemical and consulting paving engineer, New York City; Albert Sommer, consulting chemist, Philadelphia; George W. Tillson, consulting engineer to the president of the Borough of Brooklyn.

The following lectures are announced at the Royal College of Physicians, London, during November: the FitzPatrick lectures by Dr. Raymond Crawfurd on "The History of Medicine" on November 7, 12, 14 and 19, the subject being "Echoes of Pestilence in Literature and Art"; the Horace Dobell lecture by Dr. C. J. Martin, on "Insect Porters of Bacterial Infection," on November 21.

The eighty-seventh Christmas course of juvenile lectures, founded at the Royal Institution in 1826 by Michael Faraday, will be delivered this year by Professor Sir James Dewar, LL.D., D.Sc., Ph.D., F.R.S., Fullerian professor of chemistry. The lectures will be experimentally illustrated, and the subjects are as follows: "Alchemy," Saturday, December 28; "Atoms," December 31; "Light," January 2; "Clouds," January 4; "Meteorites," January 7; "Frozen Worlds," January 9. The lecture hour is 3 o'clock.

As a memorial to the late Professor Tait it is proposed to establish an additional chair of physics at Edinburgh, for which it is hoped to collect at least £20,000. The chair would be connected with the department of Tait's work in which he achieved especially conspicuous success—namely, the application of mathematics to the solution of physical problems, including those which bear upon engineering and other departments of applied science.

At a meeting held at the Mansion House to establish a memorial to Lord Lister, it was decided to put up a medallion in Westminster Abbey; to erect a monument in a public place in London; and to found an International Lister Memorial Fund for the advancement of surgery.

Dr. Oliver Clinton Wendell, assistant professor of astronomy in Harvard University, died at Belmont on the fifth instant, in the sixty-eighth year of his age.

Mr. Henry Groves, who with his brother, Mr. James Groves, is the author of important contributions to botany, died in London on November 2, aged fifty-seven years.

Dr. Heinrich Ritthausen, formerly professor of agricultural chemistry at Königsberg, has died at the age of eighty-seven years.

UNIVERSITY AND EDUCATIONAL NEWS

Mr. George F. Baker, president of the First National Bank of New York City, has given a large sum, reported in the newspapers to be $2,000,000, to bring about an alliance between the New York Hospital and the Cornell Medical College.

Dr. Arthur T. Cabot, a fellow of Harvard University, has bequeathed $100,000 to the Harvard Medical School and the larger part of his estate, estimated at $500,000, to Harvard University, after the death of Mrs. Cabot.

According to the accounting of the executors of the estate of George Crocker, Columbia University receives $1,566,635 for the Crocker Cancer Research Fund.

It is announced at the University of Rochester that $262,510 has been contributed to the endowment fund by alumni living elsewhere. Dr. L. E. Holt, of New York City, gave $10,000; J. Sloat Fassett, of Elmira, $5,000, and F. R. Welles, of Paris, $12,000.

An annual fund of $15,000 for the purpose of carrying on research work in medicine at the University of Toronto has been subscribed for five years by a few citizens of Toronto, who have become interested in medical education through the efforts of Professor Alexander McPhedran, head of the department of medicine.

Mr. Andrew Carnegie has offered to the University of Paris the last $20,000 necessary for equipping the new Institute of Chemistry in course of erection in the Rue Pierre Curie.

Graduate students in the department of botany at the University of Chicago have received the following appointments from other institutions for the present year: Joseph S. Caldwell, fellow in the department, to be professor of botany at the Alabama Polytechnic Institute; Charles A. Shull, to be assistant professor of plant physiology at the University of Kansas; Ansel F. Hemenway, to be professor of biology at Transylvania University, Kentucky; Claude W. Allee, to be instructor in plant physiology at the University of Illinois; Norma E. Pfeiffer, to be instructor in botany at the University of North Dakota, and Rachel E. Hoffstadt, to be instructor in charge of biology at Marshall College, West Virginia.

Donald W. Davis, for the past three years a student in the graduate school of arts and sciences of Harvard University, has been appointed assistant professor of zoology in Clark College, Worcester, Mass.

In consequence of the additional grant made by the London County Council to the University of London, professorships of mathematics and of civil engineering have been established at King's College. To the former Dr. J. W. Nicholson, lecturer at Cambridge, has been appointed, and to the latter Mr. A. H. Jameson, engineer of the Thirlmere aqueduct. A professorship of mathematics has also been established at Bedford College, to which Mr. Harold Hilton, of the college, has been promoted.

Dr. P. Ehrenfest, of St. Petersburg, has been appointed professor of physics at Leiden.

DISCUSSION AND CORRESPONDENCE

A SIMPLE DEMONSTRATION OF THE ACTION OF NATURAL SELECTION

In a recent presidential address, an eminent biologist referred to "such highly speculative disciplines as natural selection, Neo-Lamarckianism, neo-vitalism, etc." The criticism of natural selection implied by such association would have been quite in place a few years ago. Since it represents a widely prevailing opinion at the present time, it may not be out of order once more[1] to direct attention to the fact that natural selection is no longer neces-

[1] The progress which has recently been made by biometricians in the investigations of the selective death rate—the mortality which is not random but which is a function of the characteristics of the individual—has been reviewed in a paper,

sarily a "highly speculative discipline," but rather a field for quantitative research. Weight may be given to this statement by a brief description of an experiment made this year at the Station for Experimental Evolution.

Much of the biometric work on selective mortality has necessarily been of a highly statistical character, but this particular experiment has the virtue of extreme simplicity. In the spring of 1912, a series of about 238,000 bean seedlings was examined for morphological variations to serve as a basis for experiments in selection within the "pure line." Of these, about[2] 4,217 abnormal[3] and 5,030 normal[4] seedlings were transplanted to the field. In doing this great care was used to maintain precisely comparable conditions for both normal and abnormal plants. As plants died, from any cause[5] whatever, their labels were brought in and at harvest time a summary was prepared showing the numbers of seedlings failing to develop to fertile maturity.

Of the 5,030 normal plants, 226, or 4.493 per cent., died. Of the 4,217 seedlings showing some morphological variation from type, 286, or 6.782 per cent., failed to reach maturity.

''The Measurement of Natural Selection,'' appearing in *The Popular Science Monthly*, Vol. 78, pp. 621–638, 1911. Several other studies have been published since the writing of that résumé.

[2] The numbers given here are substantially correct, but may be slightly modified when the records are verified by checking against the labels of the individual plants. This can not conveniently be done until the 8,000 and more individually wrapped plants are opened for shelling and planting in the spring of 1913.

[3] Abnormal includes all morphological deviations from the normal type.

[4] For every abnormal seedling found at least one normal was taken quite at random from the same seed flat. The chief reason for the excess of normals is that in some lines the quantity of seed was not as large as necessary for securing a good number of abnormals, and in these cases normals were planted to avoid losing the line.

[5] An exception is made in the case of a large area of plants which were completely ruined when nearly ripe by obviously non-selective causes outside the experimenter's control.

Line	Death Rate of Typical Seedlings	Death Rate of Atypical Seedlings
1– 10	4.85	4.98
11– 20	5.16	7.46
21– 30	5.03	7.75
31– 40	4.59	6.49
41– 50	3.81	5.56
51– 60	6.80	8.39
61– 70	5.26	6.94
71– 80	3.30	5.88
81– 90	8.12	9.15
91–100	5.84	11.33
101–110	1.95	2.35
111–120	3.92	7.03
121–130	4.00	7.08
131–140	4.05	9.81
141–150	4.28	5.09
151–160	3.89	2.65

Thus under conditions of careful cultivation, with ample space, with no intra-specific and practically no inter-specific competition, and with a general mortality of less than 5.55 per cent. there is a clearly marked selective death rate.

Now if p be the number which perish in a population of m individuals the probable error of that number is given[6] by

$$E_p = .67749\sqrt{p \times \left(1 - \frac{p}{m}\right)}$$

From the absolute probable error, the percentage probable error is at once obtained by taking the ratio of 100 p to m. Thus we have for the death rates:

	Per Cent.
For normals	$4.49 \pm .20$
For abnormals	$6.78 \pm .26$
Difference	$2.29 \pm .33$

Thus the difference is seven times its probable error, and is clearly trustworthy statistically. That it is not due to chance is most strongly brought out by splitting the material up into 16 lots of about ten "pure lines" each, and determining the death rate for normals and abnormals in each lot separately. The little table gives the results.

Because of the low mortality great irregularity is to be expected in the results. *But in*

[6] *Biometrika*, 2: 274, 1903.

fifteen out of the sixteen lots the failure is higher among the abnormal than among the normal plants.

The material is classified in only the alternative categories, normal and abnormal, or typical and atypical—of which the latter is highly complex, comprising many different morphological variations in their permutations. Possibly, some types among the atypical show a lower mortality than the typical seedlings. When materials are ample I hope to determine approximately the selective value of each of the chief types of variation, both alone and in various combinations. In the meantime, the data given here may serve to record another case of the quantitative demonstration of a selective death rate.

J. Arthur Harris
Carnegie Institution of Washington

THE DOMAIN OF COMPUTATIONAL ASTRONOMY

To the Editor of Science: In the light of Professor Campbell's criticism (Science, October 25) it is to be regretted that I did not state explicitly that the domain of computational astronomy is much larger than that of the determination of orbits. This is so obviously true that it did not occur to me that my remarks could be misinterpreted. Let me amend, therefore, with the statement that Buchholz's Klinkerfues's "Theoretische Astronomie" belongs in the general field of computational astronomy.

My remark that the computational field might perhaps be called the bookkeeping, or auditing, department of astronomy may have been "unfortunate." Since it incurred the criticism of Professor Campbell I feel quite certain it was. But there is nothing in his communication which leads me to doubt its essential accuracy.

This classification of "theoretical astronomy," which was made only in the interest of exactness, clearly does not imply any disrespect for computation which is of great value not only in astronomy but in many other subjects.

W. D. MacMillan
University of Chicago,
October 25, 1912

SCIENTIFIC BOOKS

Gould and Pyle's Cyclopedia of Practical Medicine and Surgery, with particular reference to diagnosis and treatment. Second edition, revised and enlarged by R. J. E. Scott, M.D., with six hundred and fifty-three illustrations. Philadelphia, P. Blakiston's Son & Co. Royal 8vo. 1912.

In our times the medical sciences make such rapid advances that medical text-books and encyclopedic works are soon out of date. It was therefore a happy idea and a meritorious work of Dr. Scott to revise and republish Gould and Pyle's valuable "Cyclopedia," which first appeared in 1900. The new edition retains the excellent features of the first and new ones have been added. The list of contributors is a guaranty of the sterling value of the book.

The work is in size and arrangement of contents very much like those eminently practical encyclopedias of Forbes (1833), Todd (1835), Tweedie (1840), Quain (1882), which differed notably from the huge German and French works of a similar character, like those of Eulenburg (1886–89) and Dechambre (1864–89), in that they condensed a very large amount of knowledge in one or two volumes. What the general practitioner wants is not a cumbersome work of reference of twenty or thirty volumes, where he has to wade through a lengthy and exhaustive exposition of a subject, but a concise presentation of the salient facts, which he can take in in a few minutes. Such a book is the one before us. It is the only medical reference book of its kind in America and it may truly be said that it fills a much needed want.

On examining the book the reader is at once struck at the large amount of knowledge compressed in such a small space. It is, indeed, the comparatively small size of the book which gives it a great advantage over similar works. The writers have succeeded in giving the essential and important points of the various subjects in the most concise form. Titles like cerebrospinal meningitis, heart-disease, infant feeding, malarial fever, nephritis, tumors of the spinal cord, examination of urine, are presented in a most effective manner. Equally well handled are the surgical subjects. Especially worthy of mention are the titles aneurysm, gunshot wounds, hernia, surgery of the intestines, neck and stomach.

Diagnosis forms a valuable part of the work. Besides the portions on diagnosis under the various diseases such general titles as physical diagnosis of the abdomen, examination of the blood, examination of the chest and heart, pain, are presented in a concise and most interesting manner. The same observation applies to the portions which give the treatment of the various diseases.

Among the specialties the eye is especially skilfully treated. The titles cataract, cornea, glaucoma, lenses, trachoma, deserve special mention.

The work contains the latest discoveries in medicine. We find in it an account of Bier's hyperemic treatment, Brill's disease, hookworm disease, immunity, opsonines, pellagra, serum therapy. The title syphilis contains the latest additions to our knowledge of this disease; it gives a clear and concise exposition of the Wassermann reaction and of the new treatment with salvarsan.

And now we come to the defects; they are few. Some subjects are perhaps too lengthily treated, as for instance, climatology, constipation, life assurance, the latter title taking up more than six pages, which is out of proportion to the general concision of the work. We miss some titles like adalin, decompression of the brain, intratracheal insufflation, vestibular nystagmus, pantopon and a few others. But all in all the work is as complete as can be expected. The few defects are easily outweighed by the many merits the work possesses.

A number of tables of the arteries, muscles, nerves, poisons, reflexes, tumors, etc., form a valuable addition. There are 653 illustrations, those on anatomy and surgery being especially good. On the whole it may be said of this work that its defects are few, its merits many and the general practitioner will find it a valuable aid in the daily routine of his work.

A. Allemann

Army Medical Museum

Genera Insectorum, 122me Fascicule. Dermaptera. By Malcolm Burr, D.Sc. Brussels, Wytsman. December 15, 1911. Pp. 112, 9 plates.

Since De Borman in 1900 gave to the world in "Das Thierreich" his "Monograph of the Dermaptera," the number of species known to science has been doubled and the number of genera erected by various authors has been quadrupled. In 1910 Dr. Malcolm Burr published a volume upon the Dermaptera of India, Burmah and Ceylon, which was issued as one of the volumes of "The Fauna of British India" which is being printed under the auspices of the Indian government. At the time of its appearance that work was noticed by the present writer in the columns of Science. The work before us is an advance upon the former treatise in so far forth as it endeavors to outline the classification of the dermapterous fauna of the world, giving the characters of the various genera, lists of the known species, and their synonymy.

The author recognizes three suborders. The first, the Arixenina, is parasitic, and thus far is known by but one genus and species, *Arixenia esau,* described by Dr. Karl Jordan in 1909. This curious insect has the eyes only feebly developed, is apterous, and inhabits the pouch of the Javan bat *Cheiromeles torquatus* Horsfield. The second suborder, the *Hemimerina,* is likewise represented by a single genus and species. It is also parasitic, living on the widely distributed African rodent, *Cricetomys gambianus* Waterhouse. It is viviparous, apterous and totally blind. The third suborder comprises the Forficulina, or ear-wigs proper, which are oviparous, have fully developed eyes, are either winged or apterous, and have the cerci developed into horny forceps. None of them are parasitic. In the latter suborder the author recognizes three super-families, the Protodermaptera.

divided into two families in which are included fifty-two genera; the Paradermaptera, in which there is but one family, including two genera; and the Eudermaptera, divided into three families, containing seventy-seven genera.

Dr. Burr is recognized to-day as the most eminent student of this order of insects, which until recently has been somewhat neglected, but with which, thanks to his patience and learning, no entomologist need now claim ignorance for lack of adequate and authoritative treatises upon the subject. The end of Dr. Burr's labors has not, however, been reached, and he intimates that he is preparing a still more complete and elaborate work, which will deal with all known species from all parts of the world. When this task shall have been completed no order of insects will have been more thoroughly monographed than this.

The plates illustrating the present work are excellent, and with the exception of a few errors in punctuation the typography is as good as the illustrations.

W. J. Holland

College Zoology. By Robert W. Hegner. Macmillan. 1912. Pp. xxv + 733.

In this book "(1) Animals and their organs are not only described, but their functions are pointed out; (2) the animals described are in most cases native species; and (3) the relations of the animals to man are emphasized." The discussion of each phylum is introduced by an account of one or more types. The general plan is not unlike that in Parker and Haswell's "Text-book of Zoology." Hegner's book will, however, probably prove to be better suited to American students because it discusses types they may meet every day.

The book is progressive and up-to-date. Such topics as the recent work on the hookworm in the United States, and the investigations of the United States Department of Agriculture on bird foods are considered. Many old familiar names are replaced by more modern terms and we find *Trichinella* for *Trichina, Ameba* for *Amœba, Dolichoglossus* for *Balanoglossus, Anthozoa* for *Actinozoa, Branchiostoma* for *Amphioxus,* etc. The derivation of all scientific terms is given, and there is full citation of the authorities for figures. Few of the figures are original, but have been largely selected from other works. They are good for the most part.

Evidences of carelessness or hasty preparation appear in several places. For example, it is said that in the Metazoa, "the entoderm becomes the epithelium of the digestive tract, pharynx and respiratory tract" (p. 89)—a statement that will not hold true for all invertebrates; the aboral pole of crinoids is said to be "Usually with cirri or sometimes with a stalk" (p. 190) when the opposite is true; the eyes of the crayfish are said "to produce an erect mosaic or 'apposition image'" (p. 286), which would doubtless lead a student to believe that the two types of images were the same; on page 300 "*Cyclops*" is referred to as a species; *Branchipus stagnalis* is said to be a form of *Artemia salina* (p. 293), a view that has long been given up; *Polychœrus* is listed as a triclad turbellarian (p. 156); the pericardium is affirmed to be a part of the cœlom (p. 406). The book is remarkably free from typographical errors.

In the opinion of the reviewer this work is the best general college text-book of zoology that has been written up to the present time for use in the United States. The publishers have done their part in excellent fashion; the text is generally clear and understandable; the figures are good; and there is a fine index. The book contains many loose statements and some small errors; the writer has evidently been actuated by a desire to get out a good book *quickly* and has not always made conservative statements nor checked errors carefully. Nevertheless these defects are not serious enough to detract from the general value or usefulness of the work and it will doubtless continue to be popular for several years. A second printing has already been issued.

A. S. Pearse

University of Wisconsin

SPECIAL ARTICLES

THE EXPLANATION OF A NEW SEX RATIO IN DROSOPHILA

Extraordinary sex ratios have appeared at three different times in our stocks of *Drosophila*. Quackenbush described the first case.[1] Miss E. Rawls met with another case. Her results are now in press.[2] A third case has quite recently appeared in one of my other cultures not related to the last. During the past summer Miss Rawls turned over some of her stock to me. At that time some females were producing two females to one male, and other females equal numbers of both sexes.

If sex is determined by a factor in the sex chromosomes it seemed probable that some change had occurred in this chromosome. Several possibilities suggested themselves and were tested by means of the following crosses. I mated virgin females (red eyes) of Rawls's stock, in pairs, to white-eyed males. All the offspring had red eyes. Some of the F_1 females gave the 2:1 ratio. When these females were bred to white-eyed males again the following results were obtained:

Red ♀	Red ♂	White ♀	White ♂
448	2	452	374

The unusual ratio is evidently due to the almost complete disappearance of the red-eyed males, equality in all four classes being the normal expectation for this cross. On the face of these returns it seemed likely that some lethal factor must be contained in the single sex chromosome of the lost males. The lethal portion of this chromosome is derived from the red-eyed grandmother that gave the abnormal sex ratio. If this is the correct explanation, then, as the following analysis shows, all the red-eyed females in the last result should give a 2:1 ratio irrespective of the male to which they are bred. This, in fact, is the case. Similarly, the white-eyed females should give the usual 1:1 ratio; and this also proved true. The only doubtful point is the case of the two red-eyed males. If the lethal factor contained in the chromosome in question should occasionally "cross over" from the red factor, then a red-producing chromosome would result, which, if it went into a male, should give a normal male. To test this these males were united to normal females and gave normal sex ratios. The daughters of these were then tested individually and all have produced normal ratios. The explanation holds. Conversely, there are expected a few white females due to crossing over that contain the lethal factor. The chance of obtaining one is approximately 1 in 200 times. As yet this test has not been carried out. The formulas which illustrate the relation just described are as follows:

Let X = the ordinary sex chromosome and χ the sex chromosome that carries the lethal factor. The factor for red eye, R, and its allelomorph for white eyes, W, are carried by the sex chromosomes. The original female that gave a 2:1 ratio would have the formula $RX - R\chi$ and the white-eyed male $WX-$. Then

Red ♀ $RX - R\chi$
White ♂ $WX -$

$RX\ WX$ = red ♀
$R\chi\ WX$ = red ♀
$RX -$ = red ♂
$R\chi -$ = ——

Of the two kinds of red females we are concerned here only with $R\chi WX$. If she is mated to a white-eyed male the results are:

$R\chi - WX$
$WX -$

$WX\ WX$ = white ♀
$R\chi\ WX$ = red ♀
$WX -$ = white ♂
$R\chi -$ = ——

In both cases the male with the lethal factor does not develop, or dies. He does not, therefore, appear in the results except in those rare cases (the two cases above) where an interchange takes place between the sex chromosome in the female $R\chi - WX$, so that there results $RX - W\chi$.

[1] Science, 1910.
[2] *Biol. Bulletin.*

It is obvious on the other hand that half of the females also contain one sex chromosome that carries the lethal factor. They are saved by the other sex chromosome, but they will transmit the fatal dose to half of their sons who die and to half of their daughters who live.

The same test has been made with another sex-linked character, viz., miniature wings and the same results obtained. If, however, the lethal factor separates from the red-white factor ($R — W$) only once in 200 times it must be near that factor, on my hypothesis of the linear order of the factors in the chromosomes. If it does then we can calculate how often the crossing over for the wing factor should occur. In brief, we predicted the ratio of long and miniature-winged males that are expected in the back cross, *i. e.*, how many long-winged males would escape the fatal dose. The prediction was verified. For example, in F_2 there were obtained

L ♀	*L* ♂	*M* ♂
910	156	243

The number of cross-over males is 156, the number expected for the total number (399) of males is 133; this excess of long males is in the direction which the known differences in viability of long versus miniature might produce.

Similarly for the sex-linked factor for "eosin eyes." This factor lies near to the factor for red (R), hence in an experiment similar to the one with white eyes, red-eyed males should be rare. Up to the present time, 411 F_2 eosin males have emerged and one red-eyed male. The expectation is two red males to 400 eosin males.

T. H. MORGAN

COMPLETE LINKAGE IN THE SECOND CHROMOSOME OF THE MALE OF DROSOPHILA

IT has been shown recently[1] that the non-sex-linked factors that give black and wingless flies are linked to each other. In the F_2 generation (from P_1 black winged by gray wingless) there were produced:

GW	*BW*	*Gw*
2,316	1,146	737

No black, wingless flies appeared which seemed due to close linkage between the factors in question. Yet, when F_2 gray, wingless females were tested by breeding to black, winged males quite a number of black flies were obtained in the first generation (15 to 125). The explanation offered was that "crossing-over" or breaking the linkage occurred so rarely that in the production of the F_2 generation no two wingless black gametes had happened to meet.

In order to test how often crossing-over occurred, the experiment was repeated, but this time the F_1 females and males were tested for cross-overs by mating them to black wingless flies. Thus, black, winged females were mated to gray, wingless males and gave F_1 gray, winged flies. The F_1 males were tested with black wingless females and gave:

BW ♀	*BW* ♂	*Gw* ♀	*Gw* ♂
514	478	355	366

These results show that there has been no crossing-over in the F_1 heterozygous males.

The converse cross was as follows: Gray, winged females were bred to black, wingless males and produced gray, winged males and females. The F_1 males were bred, as before, to black, wingless females, and gave:

GW ♀	*GW* ♂	*Bw* ♀	*Bw* ♂
213	171	154	123

Here again the combination that went into the F_1 male remained intact.

Similar crosses in which the F_1 females were tested gave a different result: When F_1 gray, winged females (out of black, winged females by gray, wingless males) were bred to black, wingless males there were obtained:

BW♀	*BW*♂	*GW*♀	*GW*♂	*Bw*♀	*Bw*♂	*Gw*♀	*Gw*♂
696	717	305	273	180	127	606	511

The converse cross, viz., F_1, gray, winged females (out of gray, winged females by black, wingless males) were bred to black, wingless males and gave:

BW♀	*BW*♂	*GW*♀	*GW*♂	*Bw*♀	*Bw*♂	*Gw*♀	*Gw*♂
222	191	1,018	928	668	657	202	146

Adding the last two results together, it is

[1] Morgan and Lynch, *Biol. Bull.*, Vol. XXIII., p. 174, August, 1912.

found that the percentage of "crossing-over" in the female is 21.9.

These experiments make clear, first, that *there is no crossing-over in the male* (at least for the number of cases here recorded); second, that *in the female the gametic ratio is about one to four.*

The bearing of the results on the explanation of the absence of crossing-over of sex-linked characters in the male is obvious. In that case the presence of only one sex chromosome in the male made crossing-over impossible, and this was the explanation offered. But the factors concerned with black and wingless lie in a different chromosome (in the sense that they are linked to each other and not to any sex-linked factor) which is present in duplex in both sexes, yet crossing over occurs in one sex only. Whether this second chromosome is the one to which in *Drosophila* the sex chromosome is attached can not be stated, and the question must be left unsettled until we have tested the crossing-over of other factors in this and in other chromosomes.

As Mr. A. H. Sturtevant has pointed out to me, the case here recorded offers apparently an explanation of cases in plants recently described by Bateson and others.[2] When the two dominants enter from different sides no crossing over is apparent, as seen in the first case recorded above ("complete repulsion"). When the two dominants enter from the same side there is evidence of crossing over ("partial coupling"), as shown by the following example. Gray, winged females were mated to black, wingless males, and gave gray, winged F_1 offspring. These inbred produced the following F_2 classes:

BW	*GW*	*Bw*	*Gw*
9	246	65	18

These results in the F_2 generation are of the same kind as those that Bateson and Punnett have recorded for peas, etc. Back-crossing has shown in the flies that the results are due to failure of "crossing-over" in the males. If the same tests, when applied to peas, give the same result there will be no longer any need to assume, as Bateson and Punnett have done, that there is (*A*) a system of partial coupling, (*B*) a system of complete repulsion, or "spurious allelomorphism" or to assume (*C*) a system of special dichotomous ratios for coupling, such as 3:1 and 7:1, etc.

T. H. Morgan

[2] *Proc. Roy. Soc.*, Vol. 84, 1911.

THE PROBABLE RECENT EXTINCTION OF THE MUSKOX IN ALASKA

The question of the probable recent extinction of the muskox (*Ovibos moschatus*) in northern Alaska, which has often been mooted, acquires new interest through information kindly furnished me by Mr. Vilhjálmur Stefánsson, who has just returned from four years of exploration in Arctic America in the interest of the American Museum of Natural History. Under date of New York, November 2, 1912, he writes:

Dear Dr. Allen: At your request I summarize briefly my information in regard to muskoxen in Alaska secured on the museum's arctic expedition during the years 1908–12; a full statement will in due course be prepared by Mr. R. M. Anderson, who was in charge of the zoological work of the expedition.

(*a*) Information secured from natives and white residents in Alaska: During the winter 1899–1900 there died at Cape Smythe (or near there) the Eskimo man called Mangi by the whalers (probably Mangilanna). He was the last to die of Cape Smythe (Point Barrow) natives who had seen live muskoxen in that vicinity. He was probably born between 1845 and 1850, as he was able to remember Maguire's visit to Point Barrow. A few years after Maguire's time—perhaps therefore about 1858—there was scarcity of food in winter at Cape Smythe. Mangi's father then went inland looking for caribou, and some distance up the Kunk River, which flows into Wainwright Inlet, they fell in with a band of thirteen muskoxen and killed them all. Since then no one near Point Barrow is known to have killed muskoxen or seen them.

There are many places inland from Point Barrow where muskox skulls and bones are abundant. As these are heavy and there is no market for them locally, few are brought to the coast. Our party secured one skull only.

(*b*) Information based on specimens: While digging in an old house ruin about 15 miles southwest along the coast from Cape Smythe an Eskimo last summer (1912) found a muskox skin and brought it to me for sale; it is in the Point Barrow collection which has just arrived at the Museum but has not yet been unpacked. Another Eskimo found a smaller piece of skin in another house which I believe to be of a muskox, though its badly decayed condition makes it difficult to say positively that it is not the skin of the barren-ground bear.

I have myself seen muskox skulls both in the delta of the Colville (imbedded in the earth) and on Herschel Island (on top of the ground).

Respectfully,

V. Stefánnson

In this connection it may be recalled that Richardson in 1829[1] stated:

From Indian information we learn that to the westward of the Rocky Mountains, which skirt the Mackenzie, there is an extensive tract of barren country, which is also inhabited by the muskox and reindeer.

But no muskoxen were found when this section of country was subsequently visited by white men. Muskox skulls, however, have been found upon the surface of the tundra inland from Point Barrow in a condition indicating a recent and not a Pleistocene origin. Thus Mr. John Murdock, of the International Polar Expedition to Point Barrow,[2] reported that just before leaving Point Barrow in 1884 a muskox skull was brought in by one of the trading parties which had been as far eastward as the Colville River, and he presumed that the skull had been brought from there, and adds:

The natives knew the animal well, and called it by nearly the same name as the eastern Eskimos, but none had ever seen it alive. The skull obtained appeared very old and much weathered.

Some years later the McIlhenny Expedition to Point Barrow obtained "one weather-beaten [muskox] skull picked up on the tundra."[3]

[1] "Faun. Bor.-Amer.," I., p. 276.

[2] Rep., 1885, p. 98.

[3] Witmer Stone, *Proc. Acad. Nat. Sci. Phila.*, 1900, p. 35.

Mr. L. M. Turner, in referring to the muskox,[4] says:

There is no positive evidence of the actual occurrence of this mammal within the region here included [the Yukon District and the Aleutian Islands]; but, as the northern Innuit and Indians are so well acquainted with it, there can be no doubt that it has but recently disappeared, if scattered individuals do not yet inhabit the region north of the Rumianzof Mountains near the Arctic coast.

In 1898, Mr. Frank Russell[5] made the following statement:

The muskox was formerly common between the Mackenzie and Behring Straits, as evidenced by the remains which are scattered over the tundra. The oldest natives at Point Barrow say that their fathers killed muskox, which were then abundant.

Recently Dr. W. T. Hornaday has published[6] additional information furnished him by Mr. Charles D. Brower, who has lived at or near Point Barrow since 1884, much of which is in substance the same as that given above by Mr. Stefánsson. The latter, however, not only confirms the main details of Mr. Brower's account, but gives additional facts of considerable importance.

The information presented above, except that recently published by Dr. Hornaday, was gathered and published by me in 1901[7] apropos of the alleged then recent occurrence of musk-oxen along the Arctic coast of Alaska east of Point Barrow, based on three fresh skins with their skulls shipped from Camden Bay to San Francisco and thence to New York, where, through the kindness of Mr. E. Bowsky, of New York City, I had opportunity to compare them with skins and skulls from the Barren Grounds east of the Mackenzie. A communication from Mr. A. J. Stone was published in the same connection to the effect that these muskox skins must have originally been obtained by whalers around the head of Franklin Bay or on Parry Peninsula

[4] "Contr. to Nat. Hist. Alaska," 1886, p. 203.

[5] "Expl. in the Far North," 1898, pp. 235, 236.

[6] *New York Zool. Soc. Bull.*, No. 45, May, 1911, pp. 754, 755.

[7] *Bull. Amer. Mus. Nat. Hist.*, XIV., 1901, pp. 81–83.

and by them taken to Camden Bay, as he had found no evidence of the recent existence of muskoxen in northeastern Alaska. This, however, does not in any way controvert the testimony afforded by skulls found on the surface of the tundra near the coast of this portion of Alaska, nor the facts now furnished by Mr. Stefánnson in confirmation of the previous evidence of the existence of living muskoxen there as recently as fifty to sixty years ago.

J. A. Allen

American Museum of Natural History

THE NATIONAL ACADEMY OF SCIENCES

At the New Haven meeting of the academy held in the new Sloane Physics Laboratory of Yale University, from November 12 to 14, the following papers were read:

Charles D. Walcott: "Cambrian Formations of Mount Robson District, British Columbia." Illustrated.

William M. Davis: "Physiographic Evidence in Favor of the Subsidence Theory of Coral Reefs."

William B. Scott: "Restorations of Tertiary Mammals."

Henry F. Osborn: "Geologic Correlation of Upper Paleolithic Faunas of Europe and America."

John M. Clarke: (1) "The Devonian Faunas of Western Argentina." (2) "Probable Devonian Glacial Boulder Beds in Argentina."

Charles Schuchert: "Climates of Geologic Time." Illustrated.

William M. Davis: "The Transcontinental Excursion of the American Geographical Society."

Arnold Hague: "Biographical Memoir of Samuel Franklin Emmons."

Jacques Loeb: "On the Fertilization of the Egg of Invertebrates with Blood."

Edwin G. Conklin: "Cell Division and Differentiation." Illustrated.

Charles B. Davenport: "Heredity of Skin Color in Negro-white Crosses."

Lafayette B. Mendel (introduced by Russell H. Chittenden): "Some Biochemical Features of Growth." Illustrated.

Thomas B. Osborne: "The Nutritive Value of the Proteins of Maize."

Ross G. Harrison (introduced by Russell H. Chittenden): "Experiments on Regeneration and Transplantation of Limbs in the Amphibia." Illustrated.

S. J. Meltzer: "Theory and Fact as Illustrated by an Instructive Experiment on the Splanchnic Nerve."

Franz Boas: "New Data on the Influence of Heredity and Environment upon the Bodily Form of Man."

Ernest W. Brown (introduced by Edward S. Dana): "The Problem of the Asteroids."

Robert W. Wood: (1) "Some Results obtained with the most Powerful Spectrograph in the World." Illustrated. (2) "On the Possibility of Photographing Molecules." (3) "On a New Method of Finding Regularities in Band Spectra."

Charles C. Adams (introduced by William H. Dall): "The Variations and Ecological Distribution of the Snails of the Genus *Io*."

SOCIETIES AND ACADEMIES

THE ANTHROPOLOGICAL SOCIETY OF WASHINGTON

A special meeting of the Anthropological Society was held at 4:30 P.M., October 29, 1912, in Room 43 of the New Museum Building, the president, Mr. Stetson, in the chair.

Dr. I. M. Casanowicz read a very careful, thorough and interesting paper on the Mithra cult, explaining it as a religion of redemption, which was the most important competitor of Christianity during several centuries. He explained that it was Aryan in origin, antedating the separation of the Aryan people of India from the Iranians, that it was transferred westward by stages, accumulating elements in the Mesopotamian Valley and the Mediterranean Basin, but preserving an Iranian nucleus, that it entered Rome as the religion of the poor and lowly, but was taken up by society when found helpful to imperial policy and made its first convert of an emperor in Commodus. Mithra was essentially the god of light, hence of truth and benevolence; and from the antithesis of light and darkness grew the conception of his war against the powers of evil. Zoroaster built his system on this dualism and conflict, though relegating Mithra to a lower place. Later he came to be regarded as occupying a middle place (on earth) between the powers of Heaven and the evil powers of the underworld, serving also as a mediator between man and the unapproachable supreme deity. The cult of Mithra, he said, had influenced Christianity, especially in the conceptions of the powers of evil, the resurrection of the body, the efficacy of sacraments and the procedures of the church.

W. H. Babcock,
Secretary

SCIENCE

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FRIDAY, NOVEMBER 29, 1912

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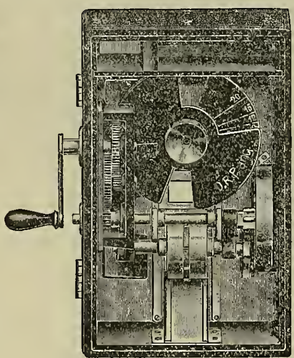

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SCIENCE

FRIDAY, NOVEMBER 29, 1912

CONTENTS

MSS. intended for publication and books, etc., intended for review should be sent to the Editor of SCIENCE, Garrison-on-Hudson, N. Y.

A NATIONAL UNIVERSITY

THE addresses by Presidents Van Hise and James, published in the August 16 issue of SCIENCE, splendidly set forth the facilities in Washington for advanced study and the reasons for a really national university. The administrative and physical organization, and also the national purposes of the proposed institution, need broad discussion.

Though its promoters might conceive the projected institution as snugly centered in a building beside or as a part of the Bureau of Education, with students directed to attend lectures in one room in each of a few scores of governmental bureaus, and working in the bureau laboratories under the seasoned government scientists, that could not be more than its preliminary stage. The mere name, "University of the United States," backed by the reputation of the scientific bureaus and libraries of Washington, would soon bring such a flood of American and foreign students that the snug executive office would be overwhelmed and the bureaus would be in revolt.

A national university at Washington must be a physical university, with existing bureaus only as adjuncts. History will prove the statement that bureau scientists and equipment can be used only incidentally. Men in charge of research and administrative science, applied to the increasing of production, to policing under pure food inspection or quarantine and other laws, to surveying natural resources, to administering public forest and other business, to promoting the public health, and even to administering educational and general public executive affairs, can be teachers and guides to research students only in an incidental way. The number of students would eventually make demands far in excess of that five to twenty per cent. of the energies of each leading scientist which can properly be devoted to graduate students. The university will want the services of only the seasoned workers, nearly all of whom have much scientific and administrative work. While President Van Hise's statement is very true, and admitted by nearly all research workers, that some teaching is a help to the scientists' research work, yet there is always the danger that the teaching will become too heavy. Students come, and the demand on the scientists' time is well nigh irresistible, as is generally proved in case of the workers in the experiment stations in the state agricultural colleges and universities.

These bureaus are even now more effective graduate schools than most people realize. The government bureaus in Washington constitute the most efficient graduate university on earth. The students (employees of the departments) are picked out by the Civil Service Commission and are employed at living wages by Uncle Sam. They enter at once under seasoned scientists into the actual technical work for which they are already in part trained by their college and university education. They are chosen on the basis both of their ability to render service and their promise of developing ability. The average is far more efficient than would be the graduates of our state universities, too many of whom "go on and take yet one more higher course because they have not impressed their teachers that they have the practical ability to succeed" and therefore were not among the graduates at once recommended for positions. This present "working university" gets the young men, and women, who are trained to do things, rather than those who can merely learn of things. These would of course continue to come, but these virile heads of bureaus and laboratories would indeed be loath to devote their time to a dilettante class of rich young men and women of native and foreign birth who come mainly to seek one more degree from the "greatest university."

A flood of these people would not only spoil the work of the departmental bureaus, but would tend to help keep the face of our educational system turned away from the more vital, toward the less vital. Our universities are already too far removed from the people. They so often look down upon the great major industries of agriculture, trades and industries and home-making, that it is refreshing to observe that the universities of Wisconsin and Illinois, over which the two speakers above mentioned preside, are turning the tide and (in the words of derision of a fellow university official) they "are spreading the university all over the state." The dangers to university life from the wealth of its students might easily be much greater in Washington than in any of the second-class universities. It would soon be in a class by itself in size and in the financial resources of its student body. I am not a pessimist, but this, as all other organizations, should be started right. To be started right, it must be built in the interests of the whole people, ninety per cent. of whom are the common people. The individual interests of its students and the interests of the universities from which they come are very secondary matters. The interests of science and of the masses are its real purposes. It must improve and correct wrong educational tendencies rather than enhance them. One of its functions should be to help turn our educational system about so as to be more vital to that ninety per cent. who are our productive classes and home makers.

Its functions can not rightfully be to merely produce men and women with so-called higher education, as too many of our higher schools of learning have too much contented themselves with doing. Recognizing that an educated aristocracy is little better than a money aristocracy, it must train people for such specific forms of service as the times require. It must train individuals, not primarily for their own interest, but that through research, invention, teaching and other forms of leadership the whole people may be made more efficient and successful. It must train workers in lines especially needed for the public good. It must not merely duplicate the state universities and colleges, but must supplement them by taking up lines they can not or will not undertake. While holding to the grade of master's degree for entrance requirement may seem a technical necessity from the mere viewpoint of the interest of the state university, yet why deny the fostering direction of such an organization to a woman, who as mother and public worker, though not a graduate, has become highly qualified to do advanced work in relation to woman's work or to children? Would it be wise to bar a man who through greatly beneficent labors for the farmers, even including a state and national legislative experience, from coming here to further equip himself for his chosen form of science or other public service? Why debar the labor leader, who has graduated in valiant and successful campaigns for the working people, because his master's degree did not come from a university? I am sure that Presidents Van Hise and James will be the last of all university presidents to run around in a circle on this matter of the breadth and depth of a national university when the whole subject is "before the house." Surely some way can be found, broader than mere graduation in a college or university, for determining who can use the facilities of the university to advantage. Achievement, not mere study, native adaptability and need, practical experience, self cultivation, along with school preparation, and promise of unusual power for public service, should be considered in selecting those eligible to use the offered opportunities for the common good.

The passing of the era of confining educational propaganda mainly to the discussion of higher education, so-called, and the entrance of the discussion of vocational education for the masses, places the discussion of any proposed university upon an entirely new plane. The educational sun has begun to shine down where most of the folks live. Their clouds are clearing away, and the light of modern science and benefits are not confined to the higher regions, educationally. The farmer, the man at the machine, the shop foreman and the mother in the home, are to have technical training, as well as the lawyer, the doctor, the preacher, the teacher and the technician. It will be different, to be sure; a larger part will be practical, but it will be substantial and effective in increasing the production and the remuneration, as well as the enjoyment, of the ninety per cent. Incidentally it will benefit also the professional classes; just as their education enables them to be of service to those who labor in the major industries and in home making, the technically educated masses will be of greater service to the professional classes.

A national university devoted simply to the interests of higher education might proceed to become a joke among folks who work for the masses. To place the possibilities of such an institution in the hands of administrators and teachers who see only abstract science and professional interests would rob it of the larger share of its possibilities. With a vital connection with the mass of people it will be on a basis of service and growth of marvelous proportions. Secretary Wilson has shown the qualities of largest university administrative sense, in sending his young workers out to the work, wherever found in America or other continents, that they might be "seasoned" for their work in the broadest possible way. No other administrator at any time has built up such a corps of seasoned men, very many of whom have been supplied to universities and experiment stations in this country and abroad. The proposed university must touch the present problems of the people, else it will become academic and pedantic, and will be attended because its certificates are valued as a matter of fashion or family pride.

The atmosphere of science and art is becoming more and more vocational and democratic. While "pure science for science sake" is growing in number of workers and in character, applied science is growing much the more rapidly. There is much of both at Washington, and a national university should recognize every phase of both. And why should it not especially deal with those phases of science, art and citizenship, which deal with national life and the life of the whole people? A division of labor would place with the universities in the states matters of local concern and with the national university matters of interstate, national and international concern. Such an institution in this greatest of nations might in many ways function as an international institution. And why should it not receive, from private sources, endowments for international functions? Among these could be the creation of commissions, financed under the guidance of the university, to study international problems. As examples of these problems, the following are worthy of suggestion:

World-wide atmospheric and weather investigations.

Studies of the seal and fishes which inhabit the high seas.

Birds which are international in their habit.

World area statistics of crop conditions, acreages, harvests, stocks in transit and in store and prospective demand; and in connection therewith the international relations of markets which deal in margins on options and futures and thus place the ownership of margins along with crop conditions as factors in determining prices.

The welfare of labor which periodically crosses international boundaries.

International relations of currency plans.

Eugenic factors needing regulation in immigration.

Other endowments, made by the public or by private parties, might deal with very many interstate matters which can not so well be studied by local universities. Even a general scientific inquiry as to the reapportionment of functions between the federal and state governments might here be made. A study might be made of all our voluntary economic and fraternal associations. The legal department might properly lead in developing the principles of cooperative law as different from corporate law—laws under which cooperative forms of production, transportation, distribution, etc., would be encouraged, with a view to the democratization of much business now becoming less democratic under the corporation laws which make for business autocracy. Here vocational education might be studied with a view to broadening out our educational system to produce at once stronger citizens and more efficient producers of wealth and makers of better homes. Our state, national and international judicial system might here be studied with a view to expediting procedure and better insuring justice and equity.

Here the academic side of the work of many governmental bureaus and commissions could be broadly studied, with the aid of the men who are in the midst of administrative experiences. Thus help might be given to the work of the Interstate Commerce Commission, the State and National Food and Drugs Board, the Census Bureau, the state and national geological surveys, the Patent Office, the Pension Office, the Plant and Animal Breeding sections of the Bureaus of Plant and Animal Industry, also the Meat Inspection Service, the Forest Service, the Biological Survey, the Labor Bureau, the Bureau of Standards—but there are too many to enumerate.

And why should such a university not find ways and means of serving the great national voluntary organizations, such as the American Federation of Woman's Clubs, the American Federation of Labor, the Chamber of Commerce of the United States, recently established in Washington, the National Education Association, the reorganized Farmers National Congress, the American Breeders Association, and the American Manufacturers Association? That a really national university represent all interests, there is need that it be under guidance by the people, not by mere academicians nor by politicians. Mr. Bush-Brown's proposal that the regency be in part nominated by the great federated bodies of voluntary nonprofit earning societies of the people, as those mentioned above, and in part chosen by the President, would accomplish this need.

Such a method of uniting for a common purpose to study and reach the truth concerning questions affecting all classes would be the beginning of a broader viewpoint among all classes, as between capital and labor, between producer and transporter, between farmers and manufacturers. The presence of a representative of the American Manufacturers Association would insure the cooperation of that body. The presence of a woman from the American Federation of Woman's Clubs would insure greater activity in research so greatly needed in relation to home making. The presence of a representative of the American Federation of Arts would insure that the major arts of expression, as oratory, music, painting and sculpture, would be given a larger leadership. A member representing genetic organizations would help to bring forward eugenic, as well as euthenic, improvements in the race. Labor and capital would here be welded together in a flux of scientific facts. The presence of representatives of religious, ethical and political economic organizations would not only soften down animosities but would aid in bringing about an equitable division of wealth and more nearly uniform opportunities for all. Thus it would not be an over-university, dominated by an aristocracy of wealth and an aristocracy of education. Its roots, through these associations of the people, should go deeply into the lives of the masses who work and make our homes.

Instead of rooms in a building beside the Bureau of Education, it should be a great institution on a large tract of land. This land nearby can not be secured a hundred years hence, and it must be within a ten minutes' rapid transit trip of the departmental laboratories on and in the vicinity of the Mall. To wait to purchase land will make impossible the future greatness of the institution, and who knows but that it may not be a world institution? A few millions invested in land will be its greatest assurance of a broad basis and of a wonderful future. A goodly allowance of land will give opportunity to here work out much that is needed to improve the outdoor recreational life of our people. When a hundred millions have been multiplied our population will more and more need leadership in the joy of living. Land will permit of instruction, outdoor laboratory work and practical experience in genetics, the creation of new forms of plants and animals by breeding, and other intense forms of agriculture and for recreation and outdoor art. Some of this can be so carried out as to give inspiration to the millions of sightseers from the states and from abroad.

While much can be arranged in way of part-time courses, as between the university and the governmental bureaus, much more of this practical mixing of real experience and schooling can be carried on in cooperation with factories, farms and other economic and professional work in all parts of the country and abroad. The local universities can be a party to many of these part-time courses. This will make it possible to use the government bureau workers as teachers only rather incidentally. It will permit the university and departmental authorities to cooperate in the division of labor of its workers. In many cases, in part owing to temperamental character, some workers should teach only; others should work only at research. In other cases the teacher or the experimenter should do only a minimum of service in another line than the one which is his or her major interest.

There will doubtless be found ways of getting away from the idea that a national university is primarily an agency to supplement state and other local universities. These institutions too long have held the high schools in line to serve the needs of the few who enter the colleges and universities, rather than the needs of the many who leave the high school and lower schools to enter practical life, thus confining vocational education to the professions, as if they had rights to be an aristocracy. The service to the public will be the large work of a national university, and service to the local universities will be only a very important incident.

For example, if the nation wants men trained for its service it will not want to confine itself to "master" graduates, especially if there are not a sufficient number presenting themselves, or if these are not of as good timber and promise as men chosen in part from other sources. For example, the State Department might desire to provide that men grown up in the consular and diplomatic service be given special lines of instruction to further prepare them for their work. The Department of Agriculture might need a winter school for its workers in farm demonstration, and for home extension teaching (it is now in great need of the finished products of such a school). Moreover, such bureaus as the Census, Agricultural Statistics, Fisheries, Indian Affairs and the Geodetic Survey, require men which, owing to the small need in any one state, are not trained in local institutions. Such a national university would properly take time by the forelock and prepare men for service in international or world governmental departments so as to be ready when world peace comes. Thus the International Institute of Agriculture at Rome will require men versed in world area crop statistics and other similar service—and no university has anticipated the demand for workers along these lines. The public requirement runs all the way in grade from secondary to graduate work preparation. Then there is the demand in the district for an undergraduate institution, such as would be provided if congress accede to the District's request for the privileges granted each state under the A. and M. land grant

College Act, which might properly be a part of a national university.

No greater boon has come to some of our universities, for example, those in Wisconsin, Illinois and Minnesota, which have secured means for such large service, than has come through college extension departments to serve those not resident in schools, to the mature farmer, mechanic and home maker. And the federal government already has in hand a stupendous work of this kind in its bureaus of farm demonstration and farm management. A national university, with its regency in part nominated by the great federated bodies of societies representing all phases of industry, home-making, education and art, might here have its greatest function. Mr. Bush-Brown's idea of a people's education foundation under the auspices of such a board would probably grow into a vastly greater work than the service to students resident in Washington.

Such a foundation could federate with all the private foundations, the national and state bureaus of education, the educational institutions of all states and the federated bodies supplying members to the regency for the most effective educational service. Under its guidance our educational machine (shown by the Carnegie Foundation and the General Education Board to be so disjointed and poorly coordinated) would be made vastly more efficient. Private fortunes would come to such a foundation, with its semipublic plan of control, and at the same time congress might find reason to provide liberally for its needs along all lines clearly meeting public demands.

It is manifest that this subject needs more discussion. The possibilities are so very large that wide consideration should be given that the more essential factors be brought boldly to the forefront. A move now to establish a university will make a new era in higher education. But one of its chief lines of work should be to foster vocational education for all the people in the lower schools. The better the lower schools are in giving efficiency to the producing classes, the more financial support and the more well-prepared students will come to all universities. But that is a small consideration beside the one of providing vocational education just below those rounds of the educational ladder from which the masses actually do and will leave to enter the work of producing and home-making. A board of regents in large part selected by and from the various classes of people, and a public educational foundation, supplied with means through which such a regency can reach and guide and build up the masses, will make not a Washington institution, but a national university; not a campus college but a university spread all over Uncle Sam's domain; and may become a beneficent world foundation to help take our freedom, our ideals and our opportunities to all the people in all the world.

Willet M. Hays

UNDERGRADUATE RESEARCH WORK IN MEDICAL SCHOOLS

It has undoubtedly become true that a man with a real desire to gain all he can from his four years in the better type of American medical school can not be free very long from the idea that he must know something of the methods of investigation in medicine, or else graduate lacking an important element in his training. I am not referring to the man who feels he will favor the world with a cure for cancer as soon as his osteology course is finished, but to the steady well-prepared workers who make up the first third of every medical class. These men find themselves launched on a traditionally inspiring sea. They are far too acute not to know that their strongest leaders are the imaginative, productive spirits in their new life and they want to follow the best. It is not amiss for such men to feel they have a right to gain some notion of what investigation entails. Such information is gathered to some extent in the laboratories of the first and second years, but in most instances it is to a very small extent. The doing of fixed experiments in fixed hours does not entail the exercise of investigative faculties other than those of the most mechanical nature. The student receives instructions as to the setting up of apparatus and the preparation of his material. If he follows these faithfully and accurately he is reasonably certain of gathering the data for the necessary conclusions. Perhaps from his primary deductions he is required to generalize some governing principle of the widest application. At best he has had almost no chance for the use of his imagination; he has never learned the meaning of high scientific accuracy. He has no true notion of the difficulty of putting a problem on a working basis. I believe it must be the lack of just such powers which leads to the adverse criticism of so many American students in German universities.

The student more or less realizes these facts and when in his third and fourth years he finds he can get access to the laboratory most attractive to him, he takes his scraps of time and does what he can. Is it worth while to meet him half way?

Six years ago the medical students of the University of Pennsylvania organized the Undergraduate Medical Association, modeled upon the American Medical Association, and having for its constituent parts the numerous medical societies which are a constant part of student life. The organization planned one large meeting a year, when original papers were to be presented. The success of the meetings has varied considerably. This, as will appear later, must necessarily be so. Fourth year men do the largest part of the work, beginning in their third year and finishing the following April. If they are to do anything worth while they must expect to pay the price of slackening in their other work, and it occasionally happens that there are not many men in a class who dare to do this. I do not believe it ever happens that there are not many who would be glad of a chance to do some independent work, but, as a rule, under the circumstances of an inflexible curriculum, there are not enough who dare to carry this to a successful conclusion.

Such men receive all possible encouragement from the faculty, and in reason they are given every facility for their work. But the assistance never takes the vital, practical form of *time to work*. The student investigator must keep abreast of his fellows and do his experiments when he can. With the present medical course this "when" requires considerable research for the discovery of its existence. Since such a situation must unfailingly hamper the activity of the Undergraduate Medical Association it was decided to attempt to better it, and with the encouragement and help of Dr. Allen J. Smith, the dean of the faculty, the following investigation was undertaken.

Twenty-five medical schools were selected as a basis of investigation. It is evident from the lists given that they represent fairly well the various types of effort in the field of medical education. The deans of these schools, with the exception of Johns Hopkins, received the following letter and questions. In the case of Johns Hopkins the letter was sent to Dr. W. H. Howell, and his reply must be regarded as the expression of a personal opinion rather than an official statement from his school. The deans of two other medical schools, Cornell and the University of Toronto, failed to respond to the first letter, and in these two cases a second letter was sent to selected professors, Dr. James Ewing in the one case, and Dr. J. B. Leathes in the other.

Philadelphia, Pa., April 22, 1912

Dean of the Medical Department,

Dear Sir: It is the contention of some of the undergraduates of this school that certain carefully selected men should be given permission and special privileges in the working out of research problems. At the present, while post-graduate research is favored in every way, undergraduates are allowed no deviation from the regular curriculum and little opportunity for original investigation. Before any changes are made in the present system it has been suggested that inquiry be made into the status of undergraduate research work in other schools. With this in view I have prepared the accompanying list of questions, to which I request the favor of a reply, together with any further suggestions or comments which you may care to make.

Thanking you, I am,

Very truly yours,

Cecil K. Drinker, *Chairman,*
Research Committee of the Undergraduate Medical Association of the University of Pennsylvania

QUESTIONS

1. Do you allow undergraduates to undertake research in conjunction with their regular medical work?

2. Do you give such men any immunity from work in their regular courses?

3. How do you select men for such work—is it done entirely by the department to which they apply or do you have a faculty committee to deal with such applications?

4. Do you believe that the original work turned out by these men justifies the time they have taken from their course?

5. Do you believe that the care your faculty has taken to produce and further such work has resulted in your school turning out effective laboratory men in larger proportion than it would have without such a policy?

DISCUSSION OF THE FIVE QUESTIONS

First Question

Do you allow undergraduates to undertake original research in conjunction with their regular medical work?

Seventeen colleges out of the twenty-five give an affirmative answer to the first question. They are:

1. Albany Medical College.
2. University and Bellevue Hospital and Medical College.
3. University of California.
4. University of Cincinnati.
5. Cornell University.
6. College of Physicians and Surgeons of Columbia University.
7. Harvard University.
8. Johns Hopkins University.
9. University of Michigan.
10. University of Minnesota.
11. Northwestern University.
12. Rush Medical College.
13. Tulane University.
14. University of Virginia.
15. Washington University.
16. Western Reserve University.
17. Yale University.

Eight colleges answer in the negative. They are:

1. Atlanta College of Physicians and Surgeons.
2. Jefferson Medical College (permits in the summer).
3. McGill University.
4. University of North Carolina.
5. University of Pittsburgh.
6. University of Tennessee.
7. University of Texas (permits in the summer).
8. University of Toronto.

Therefore, in all, seventeen schools permit undergraduates to undertake research and eight do not. If we classify all these schools upon the basis selected by Mr. Flexner in the first report of the Carnegie

Foundation on Medical Education, namely upon the possession or lack of a two years' college entrance requirement, we find that of the schools permitting undergraduate research five fail the test:

1. Albany Medical College.
2. University and Bellevue Hospital and Medical College.
3. University of Cincinnati.
4. Tulane University.
5. University of Virginia.

If we examine the other side we find not a single school meeting the Carnegie requirement. Some of the schools giving negative replies make it clear in their letters that they do not indulge in the policy of furthering the research spirit because of the need of the country for "practical men" or "capable family doctors." It is difficult to conceive however of a really "capable family doctor" who can not think scientifically, or of a "practical man" without practical facility in the scientific investigation of his cases.

Question Two

Do you allow such men any immunity from work in their regular courses?

We find only one school, Tulane University, going to the extreme indicated by the question. Their attitude is best explained by extracts from the letter of Dr. Isadore Dyer, the dean.

Answers to questions one and two:

1. Undergraduates in their last three years are encouraged to do original research in conjunction with their regular medical work. As yet there has been no systematization of this kind of work in the Tulane Medical Department and, so far, the men undertaking such work have been compelled to forego a part of their regular curriculum.

2. In the fourth year men are assigned to the laboratories of pathology and clinical medicine as assistants and, in such capacity, are not only permitted but are encouraged to do original work. In their capacity as assistants they are excused from other work which might interfere with such function.

One can not help feeling that a similar condition exists in other schools, but brought about in a different manner. Suppose a medical course contains a certain number of elective hours—elective in the sense that they may be filled by extra routine work in the various subjects of the course or by research. Men must complete a certain number of hours or units to graduate. They are given no "immunity from work in their regular courses," but they do not need it, since they can make a successful research a factor in getting the degree, quite as well as the passing of an examination in some required subject.

The question, therefore, takes a broader basis and becomes: What schools make undergraduate research possible by a concession of hours in the regular roster? Nine schools answer such a question affirmatively. They are:

1. University of California. This school announces that

the more proficient students are encouraged to do advanced work in the line of original research, particularly in anatomy, physiology, pathology and experimental surgery. (Letter of Dr. A. A. D'Ancona.)

The catalogue shows a roster of sufficient elasticity to allow successful work.

2. Harvard University. No free hours are given until the fourth year, when the following arrangement is made.

The electives of the fourth year are given as half-courses and quarter-courses. A half-course occupies the entire day for one month (the all-day plan) or the forenoons or the afternoons for two months (the half-day plan). Each half-course has a value of one hundred and twenty-five hours. Quarter-courses occupy half the day for one month. Two quarter-courses equal a half-course. Eight half-courses are necessary to satisfy the requirements of one thousand hours of work demanded in the fourth year.

Students wishing to specialize in any particular branch of medical studies may elect more than one of the half-courses offered in a given subject, but no student will be allowed to devote his whole year to one subject without the consent of the head of the department concerned.

When a student's research work in an elective is necessarily prolonged beyond the time elected for that subject, he will be allowed, with the permission of the Administrative Board, to make such changes in his electives as will enable him to finish his research work, provided the time required does not extend beyond the school year. (Catalogue of Harvard University Medical School, 1911–12, p. 55.)

3. Johns Hopkins University. In the first two years we find that

the major portion of the work of these years is obligatory for all students, but the time is so arranged that certain elective courses may be selected; thereby making it possible either to give more time to the obligatory courses, or to do special work along the related lines. When any elective course has been selected it must be completed satisfactorily if credit is to be obtained for it. (Johns Hopkins University Catalogue, 1911–12, p. 116.)

In the third year

on certain afternoons there are also offered a number of short elective courses of a practical character, and each student is required to select from them a sufficient amount of work to give him a credit of one and a half units—the unit for the last two years being defined as a course or group of courses equivalent to six hours a week for one trimester. (Johns Hopkins University Catalogue, 1911–12, p. 117.)

In the fourth year the class is divided into three groups, each working in rotation for one trimester in medicine or surgery, or in certain elective courses. For one third of their time the students are given an opportunity to vary their studies according to their special needs and may choose from a large number of elective courses. (Catalogue, p. 117.) The courses so elected may continue the practical work in medicine, surgery, obstetrics, gynecology, etc., or may bear upon the special branches of medicine, or may be taken in the scientific laboratories. Each student, in other words, after completing certain minimal requirements, chiefly in medicine and surgery, may extend his knowledge by taking a number of short clinical courses in different departments, or he may concentrate his attention upon the work of a few departments. (Catalogue, pp. 118–119.)

A quotation from Dr. Howell's letter is of interest:

The committee controlling the work of the first two years decided also that students who had shown inability to carry the required work successfully, as shown by their marks, should not be permitted to engage in advanced or research work.

4. University of Michigan. In the first year an optional course in topographical anatomy is given from April 15 to the end of the term. At the same time stipulation is made that

students desiring to follow a laboratory career may substitute other work for the latter course by applying to the professor of anatomy. (Michigan Catalogue, 1912–13, p. 25.)

Other opportunities are given in anatomy, introduced by the following paragraph:

It should be pointed out that in addition to the information and technique acquired in their accomplishment, the special study of such problems possesses the additional value of developing independent thought and the work is strongly recommended to all students planning to follow a university or laboratory career. (Michigan Catalogue, 1912–13, p. 28.)

The same principle holds for the three following years. Saturday work is not required except in the third year, and the students are thus given a fair allotment of time for independent work and thought. The letter of Professor Victor C. Vaughan sums up the Michigan attitude:

1. We not only allow, but encourage undergraduates to undertake research work, provided they have good standing in their regular work. They must not, under any circumstances, shirk their regular work in order to do research.

2. We do not give immunity from the routine work to those who do research. During the fourth year there is one period of three months in which the bright student has half the day to do research work. In addition to this, many students do some of their ordinary work in the summer session, and in this way get from six to eight weeks ahead of the class. This time they may devote to research work. (Extracts from letter received May 9, 1912.)

5. Rush Medical College. Elective courses are given in all four years. The quarter system in vogue in this school is so essentially elective and gives such great latitude in the whole school career that it is useless to try to give any adequate notion of how much time a man may be permitted to spend on research.

The letter of Dr. H. Gideon Wells expresses the situation excellently.

> We have always laid the greatest stress on research work by undergraduate students in the medical courses. This is not a new thing, but dates back to 1895. Since that time there have always been several undergraduate students engaged in research, at first chiefly in the department of pathology, but since the university took up medical work eleven years ago, in all departments. We not only permit research by our students but encourage it in every way possible. We even send notices to the colleges throughout the country from which our students come that we offer prizes for undergraduate research work, and I enclose a copy of the same. I am pleased to announce that negotiations are now under way whereby an additional cash prize of $200 will be awarded annually for undergraduate research in pathology or bacteriology.
>
> We do not excuse research men from any of the ordinary courses, but we do not stuff our curriculum so hopelessly full of required work that capable and energetic young men can not find time for original investigations, and commencing next year one quarter is left entirely open for elective work. Our quarter system permits of much elasticity in the curriculum, and a man with the research spirit is usually willing to put in extra quarters at work, the university being open all year. Most of the best men in our first two years do research work or assist in it, and a considerable proportion spend from one to three years extra time between the second and third years of the medical courses, in working for a master's or doctor's degree. I always have a class of from six to ten men who are candidates for the degree of Ph.D., taking either their major or minor in pathology. The men who do the work either request the privilege or are selected by the departments, most of them receiving aid in the form of fellowships or scholarships from the university.

6. Tulane University. Dealt with on page 54.

7. University of Virginia. Here we find that

> opportunities are offered in the fourth year for more extended training in certain subjects with a view towards possible specialization after graduation. (Catalogue University of Virginia, 1911–12, p. 199.)

These opportunities are given in physiology, pathology and bacteriology, and mean six hours a week for half a year. Four students only may be taken in physiology.

An extract from the note of Dr. R. H. Whitehead is as follows:

> Our curriculum is planned for the "average man," and it keeps such a man quite busy; he can hardly do anything else to advantage. But the exceptional man can often undertake some line of investigation with results that are distinctly beneficial to him and creditable to the school.

8. Washington University. Elective courses are given through the four years. Specially qualified students are permitted, at the discretion of the heads of the departments involved, to take up original research instead of these electives. They can obtain units for graduation by means of such work.

9. Yale University. Elective courses are given in all four years. The requirement of a thesis for graduation necessitates a certain amount of open time through the course and men may make original work the basis of the thesis.

Schools permitting research and giving no visible time for it are as follows:

1. Albany Medical College.
2. University and Bellevue Hospital and Medical College.
3. University of Cincinnati.
4. Columbia University.
5. University of Minnesota.
6. Northwestern University.
7. Western Reserve University.

Of these schools Columbia, Minnesota, Northwestern and Western Reserve meet or more than meet the two years college entrance requirement.

When we add to these the eight schools which do not permit research or allow it only in the summer, namely:

1. Atlanta College of Physicians and Surgeons,
2. Jefferson Medical College,
3. McGill University,
4. University of North Carolina,
5. University of Pittsburgh,
6. University of Tennessee,
7. University of Texas,
8. University of Toronto,

we have grouped the lukewarm and negative side of the whole proposition. Not one of this last group requires two years of college work.

Third Question

How do you select men for such work—is it done entirely by the department to which they apply or do you have a faculty committee to deal with such applications?

Tulane University requires that research men, after being passed upon favorably by the department to which they have applied, obtain the consent of the dean and president of the university. All other schools have the selection in the hands of the departments alone.

Without going into every answer, it may be given as the strong opinion of all the schools that only certain men should be allowed to undertake original investigation. Where there are elective hours which may be filled by research, it is always carefully stated that the selection is controlled by "previous standing," "special fitness," etc., so that those who would probably become unsuccessful investigators are barred from starting and take other elective hours in line with the regular work. The whole policy of furthering undergraduate research is, therefore, levelled at a small number of men, and it is most significant to know that many of our greatest schools find it worth while to pursue such a policy.

My answers to this question emphasize another fact. Research spirit is fostered by example, not by coaxing. Free hours are given which may be filled by research, but permission to so fill them is in the nature of a prize. As Dr. Howell says, "the researchers become marked men," and Dr. Christian,

The medical curriculum should be elastic enough to allow each student a certain amount of time which he may occupy in accordance with his own ideas. Most students will and should occupy this time in studying a little deeper some of their regular subjects. The occasional student will occupy it in some form of investigation. The latter type of student, I am inclined to think now, finds time for investigation. [Note, page 55, Harvard gives more chance for such students than any other school except Rush.] You can not create such students by any rule. Any systematic move to develop research work among the students appears to me, on the whole, to be farcical, because original investigation is not so produced. No student should be encouraged to neglect his regular work for investigation. The brighter student can do his original work after he has kept pace with his classmates.

This expresses the view which should be taken of the whole matter. It does not come from a school where undergraduate research is forbidden nor where it is made an ornament of the catalogue, but from one which furthers it in every way in the right men. That is the inevitable conclusion from this study—not unlimited, uncontrolled hours, which is the meaning of the word *elective* to most people, but controlled and counted hours for men who must justify their selection or suffer from their failures, just as men must suffer who do not do their work in any one of the prescribed courses.

Question Four

Do you believe that the original work turned out by these men justifies the time that they have taken from their course?

Affirmative answers from:

1. University of California.
2. Johns Hopkins University.
3. University of Michigan.
4. Northwestern University.
5. Rush Medical College.
6. University of Virginia.
7. Washington University.
8. Western Reserve University.
9. Yale University.

The following do not answer the question:

1. Albany Medical College.
2. Atlanta College of Physicians and Surgeons.
3. Jefferson Medical College.
4. Harvard University.
5. University of Minnesota.
6. University of Texas.

Negative answers come from:

1. University and Bellevue Hospital and Medical College.
2. University of Cincinnati.
3. Cornell University.
4. Columbia University.
5. McGill University.
6. University of North Carolina.
7. University of Pittsburgh.
8. University of Tennessee.
9. Tulane University.
10. University of Toronto.

Opinions upon the question from several schools are as follows:

Dr. Howell (Johns Hopkins):

Some men have told me that their experience in research was of the greatest value—an intellectual awakening. I have known of others who have fallen by the wayside and made the instructor himself feel that the time was wasted. On the whole all of us believe in its value, otherwise we would discourage it—not, I fancy, for the value of the scientific results obtained, but for its educational value on the picked men and the belief that the group of the serious workers in medical science will be recruited from this body of students.

Dr. H. Gideon Wells (University of Chicago):

There can be no question as to the value of the work which has been turned out by our undergraduate investigators, but that is a very secondary consideration compared with the influence on the men themselves.

Dr. Victor C. Vaughan (University of Michigan):

Some very good original research has been done by our undergraduates. We have what we call the Junior Research Club, made up principally of assistants and students and encouraged by members of the faculty.

Dr. I. H. Manning (University of North Carolina):

In my judgment the student is unprepared to do creditable original work.

Fifth Question

Do you believe that the care your faculty has taken to produce and further such work has resulted in your school turning out effective laboratory men in larger proportion than it would have without such a policy?

Affirmative answers come from:

1. University of California.
2. Harvard University.
3. Johns Hopkins University.
4. University of Michigan.
5. Rush Medical College.
6. University of Virginia.
7. Washington University.
8. Western Reserve University.
9. Yale University.

Schools giving no answer are as follows:

1. Albany Medical College.
2. Atlanta College of Physicians and Surgeons.
3. University and Bellevue Hospital and Medical College.
4. University of Cincinnati.
5. Jefferson Medical College.
6. University of Minnesota.
7. University of North Carolina.
8. Northwestern University.
9. University of Texas.
10. Tulane University.

In regard to Tulane the answer of Dr. Dyer is as follows:

The policy above iudicated has been too recent to justify any reply to your fifth question, but it is my personal belief that the sympathy of the faculty with the research spirit in students is bound to make better laboratory men. More than this the demand for men trained in the laboratories as now obtains in the south and will obtain hereafter, makes it more than a policy for the future.

Schools answering in the negative are:

1. Cornell University.
2. Columbia University.
3. McGill University.
4. University of Pittsburgh.
5. University of Tennessee.
6. Washington University.

Certain interesting opinions are as follows:

Dr. Howell (Johns Hopkins):

I have no doubt whatever that the custom as it exists in our school has been responsible in determining the course of a large proportion of our men who have subsequently undertaken investigation as a life work.

Dr. Vaughan (University of Michigan):

I am quite sure that the encouragement given to our brighter students to do research work has resulted in drawing out many more effective laboratory men than would have been the case had we not encouraged research.

Dr. H. Gideon Wells (University of Chicago):

Nearly all the investigators who have graduated from Rush Medical College have done undergraduate research work, and I would criticize your question 5 to the extent of saying that the research work turns out more efficient practitioners as well as laboratory men, for a practitioner should look on each case as a problem for investigation and approach it with the same spirit that a laboratory man approaches his problem.

Dr. George Dock (Washington University, St. Louis):

Probably yes, but it is impossible to say positively. The fact that graduates are active investigators should stimulate just as many men to take up laboratory careers after graduation. In some cases premature work in investigation has kept men from getting a good grounding.

Dr. Samuel W. Lambert (Columbia):

I doubt very much if any special results can be traced to such a course.

In summing up the whole matter, I think it is evident that there is a decided tendency in the foremost schools to give time in the curriculum for independent work and thought, and the tendency to turn certain men to a laboratory life as well as to the better type of medical practise. Dr. Lambert, in replying for Columbia, one of the schools giving a pronounced negative throughout, adds to his letter:

I would here state that the committee on scholarships recently recommended to the faculty beginning next fall, "that four awards of $350 be made to undergraduate students; that holders of these scholarships be assigned as student assistants, two to the department of anatomy and two to the department of physiology, and that they shall render such services to the said department as may be assigned them by their respective heads."

This does not mean original work, but it does point to a method of making men better acquainted with the laboratory and giving them a chance to learn their own fitness for such work.

It is also evident that only a very limited number of carefully selected men should be allowed to do research work and that such work should be permitted to count for the degree. There is a practical unanimity of opinion that no man should be allowed to slight his regular work for research, and since he is working for a degree he should have quite as great a responsibility toward his research if he is given the privilege of entering upon it.

The amount of time which different schools give is varied, so varied that no estimation can be made of what is fair. It is obvious, too, that mere numbers of hours mean little, since a small number of consecutive hours may easily be of more use than a large number hopelessly scattered, which never permit more than the hurried starting of experiments and bring no satisfaction either to the student or his professor.

Finally the belief may be emphasized that experience in actual investigation must be of immense benefit to the student who wishes to approach medicine in the scientific spirit which the times demand. The use of sphygmographic tracings, blood-pressure determinations, and quantitative chemical analyses as every-day aids in the elucidation of a diagnosis requires a mind trained to think in such terms. This is the reason the student turns to the laboratory. He wishes to find out how problems of investigation are approached in order that he may make successful problems of his cases. If, as Dr. Howell believes, "the group of serious workers in medical science will be recruited from this body of students," from the men who, in the words of Dr. Wells, will approach each case "in the same spirit that a laboratory man approaches his problems"—then surely it is worth while to make room in the curriculum for their growth.

Cecil K. Drinker
University of Pennsylvania

SCIENTIFIC NOTES AND NEWS

The council of the Royal Society has made awards as follows: A Royal medal to Professor William Mitchinson Hicks, F.R.S., for his researches in mathematical physics and investigations on the theory of spectroscopy. A Royal medal to Professor Grafton Elliot Smith, F.R.S., for his researches on the comparative anatomy of the brain. The Copley medal to Professor Felix Klein, of Göttingen, For.Mem.R.S., for his researches in mathematics. The Rumford medal to Professor Heike Kamerlingh Onnes, of Leyden, for his researches at low temperatures. The Davy medal to Professor Otto Wallach, of Göttingen, for his researches on the chemistry of the essential oils and the cyclo-olefines. The Darwin medal to Dr. Francis Darwin, F.R.S., for his work in conjunction with Charles Darwin, and for his researches in vegetable physiology. The Buchanan medal to Colonel William C. Gorgas, of the United States Army, for his sanitary administration of the works of the Panama Canal. The Hughes medal to Mr. William Duddell, F.R.S., for his investigations in technical electricity.

The council of the Royal Society has made nominations for the year 1913 as follows: *President,* Sir Archibald Geikie; *Treasurer,* Sir Alfred B. Kempe; *Secretaries,* Sir John Bradford, Professor A. Schuster; *Foreign Secretary,* Dr. D. H. Scott; *Other Members of the Council,* Lieut.-Col. A. W. Alcock, Mr. A. J. Balfour, Sir William Crookes, Dr. F. W. Dyson, Professor W. Gowland, Sir Joseph Larmor, Professor E. W. MacBride, Mr. W. B. Hardy, Professor Micaiah J. M. Hill, Sir Ronald Ross, Professor G. Elliot Smith, Professor A. Smithells, Dr. J. J. Harris Teall, Professor Silvanus P. Thompson, Sir J. J. Thomson and Sir Philip Watts.

Captain Roald Amundsen, who lectured before the Scottish Geographical Society on November 21, was given the Livingstone Gold Medal of the society.

Professor G. A. Miller, of the University of Illinois, was elected a corresponding member of the Spanish Mathematical Society at its general meeting, held at Madrid, April 26, 1912. The only other corresponding member of this society is M. H. Brocard, of Bar-le-Duc, France.

The governing body of Magdalene College, Cambridge, has awarded a research studentship to Mr. E. Hindle, B.A., Beit fellow, who has been working at pathogenic protozoa in the laboratory of Professor Nuttall.

The annual public address of the Entomological Society of America will be given at the Cleveland meeting of the society on Wednesday evening, January 1, at 8:00 p.m., by Dr. Philip P. Calvert, of the University of Pennsylvania. His subject will be "An Entomologist in Costa Rica." He will give an account of a year spent in this entomologically very rich country, primarily for the study of the seasonal distribution, life-history and habits of Odonata, but including references to other groups of insects, characteristics of various collecting grounds and topics of general interest.

Mr. Newton D. Baker, mayor of the city of Cleveland, will give a series of public addresses on four successive Sunday evenings, at 8:00 o'clock, in the Amasa Stone Memorial Chapel of Western Reserve University. The dates and subjects are as follows:

November 24—"The City's Housekeeping."
December 1—"The City's Safety."
December 8—"The City's Health."
December 15—"The City's Ideals."

This series of lectures is a part of the university's program of coordination with municipal and other public interests.

The College of Engineering of the Ohio State University will offer a course of nine lectures this winter. Prominent engineers and business men will be among the speakers. The purpose of the course is to broaden the acquaintance of the engineering students in the general field of engineering. On January 24, Mr. C. E. Skinner, M.E., of the Westinghouse Company, will lecture on "Research in its Relation to Manufacturing Problems."

Professor C. E. A. Winslow, of the College of the City of New York, lectured on November 21, before the Columbia Chapter of the society of Sigma Xi, on "Some Newer Aspects of the Public Health Campaign."

In a recent address before the Minnesota Pathological Society, Professor Ludwig Hektoen, head of the department of pathology and bacteriology in the University of Chicago, discussed the epidemics traceable to contamination of milk with streptococci, particularly the epidemic of sore throat in Chicago last winter which involved not less than 10,000 cases and was traced to contamination of a definite milk supply.

At the meeting of the College of Physicians, Philadelphia, on November 6, portraits of the late John H. Musser, Isaac Hays and Wharton Sinkler were presented to the college, the addresses being made by Drs. George A. Piersol, George E. DeSchweinitz and James C. Wilson, respectively.

Dr. Arthur Tracy Cabot, the distinguished Boston surgeon, a fellow of the corporation of Harvard University, has died at the age of sixty-two years.

The death is announced, at the age of ninety years, of M. Aimé Pagnoul, a correspondent of the Paris Academy of Sciences in the section of rural economy.

A committee consisting of Drs. Clarence John Blake, John Warren and Frederic T. Lewis, appointed to prepare a memorial to Dr. Leonard Worcester Williams, has presented the following report:

Dr. Leonard Worcester Williams, instructor in comparative anatomy, died in the thirty-eighth year of his age, while absorbed in his work at the Harvard Medical School. Dr. Williams was a naturalist by instinct and education, and took great delight in examining marine creatures of all sorts. In this way he acquired rare technical skill in dissection and broad knowledge of the structure of animals. In 1907 he joined the department of comparative anatomy, and became at once a welcome and most valuable member of the staff. Exquisite preparations remain as permanent mementos of his industry, and his publications are those of an earnest student, careful, painstaking and exact. Of Dr. Williams's personal traits none was more generally recognized than his obliging readiness to help others. During the recent Otological Congress he left his work at the Biological Laboratory in Woods Hole to arrange and direct the display of microscopic specimens. For two weeks in mid-summer his time was at the disposal of the congress, in one form or another of helpfulness. In recognition of such loyal service, freely rendered throughout the five years that Dr. Williams was our associate, we record our high appreciation of his labor in our behalf, and our deep sense of loss in his death.

In connection with Mr. Andrew Carnegie's offer to provide pensions for future ex-presidents of the United States and their widows —chiefly interesting to university men for the light it throws on his provision of pensions for professors—it is announced that Mr. Carnegie has transferred $125,000,000 to the Carnegie Corporation of New York incorporated under the act of the legislature introduced on March 22 last year. This corporation has eight trustees, five of whom are the heads of the five institutions which Mr. Carnegie has founded—the Carnegie Endowment for International Peace, the Carnegie Foundation for the Advancement of Teaching, the Carnegie Institution of Washington, the Carnegie Hero Fund, and the Carnegie Institute of Pittsburgh. The heads of these are Senator Elihu Root, Dr. Henry S. Pritchett, Dr. Robert S. Woodward, Mr. Charles L. Taylor and Dr. William N. Frew. The other three trustees are Mr. Carnegie, Mr. Robert A. Franks, president of the Home Trust Company, and Mr. James Bertram, Mr. Carnegie's secretary. By the act of the legislature the incorporators were authorized "to receive and maintain a fund and apply the income to promote the advancement and diffusion of knowledge among the people of the United States by aiding technical schools, institutions of higher learning, libraries, scientific research, hero funds, useful publications, and by such other agencies and means as shall from time to time be found appropriate."

After the annual meeting of the trustees of the Carnegie Foundation for the Advancement of Teaching last week it was announced that forty-eight pensions and retirement allowances had been granted during the year, making a total of three hundred and ninety-eight now in force at an annual expenditure of $570,000. Dr. William F. Slocum, president of Colorado College, was elected to the vice-chairmanship of the board to fill the place of Dr. David Starr Jordan, resigned. Endowments of the Foundation now amount to $14,000,000, Mr. Carnegie having added $2,000,000 since the meeting of the trustees a year ago. The foundation was created with a fund of $10,000,000 and a promise of $5,000,000 more from Mr. Carnegie when it was needed for the state universities. The gift announced last week makes three of the additional five million; during the first years of the foundation's existence it saved $1,000,000 of its income.

The U. S. Civil Service Commission announces a competitive examination for inorganic chemist, for men only, on December 4 to fill vacancies in this position in the Bureau of Insular Affairs, Philippine Service, at salaries ranging from $1,400 to $2,000 a year.

The Illinois Civil Service Commission expects to hold an examination in Chicago on December 14, 1912, to furnish an eligible list for the position of curator of the State Museum. Applicants are not restricted to residence in Illinois but the law requires that they must be geologists and over twenty-five years of age. The present salary is $250 per month. The examination will cover the training and experience of the applicant and in addition will include questions on geology and natural science, museum organization and administration and methods of collection and exhibition of specimens in large museums. A portion of the examination will be oral. This is the first time that such an examination has ever been held for scientific positions in the state service of Illinois.

The committee in charge of the Sarah Berliner Research Fellowship for Women offers annually a fellowship of the value of one thousand dollars, available for study and research in physics, chemistry or biology, in either America or Europe. This fellowship is open to women holding the degree of doctor of philosophy, or to those similarly equipped for the work of further research. Applications for this fellowship must be in the hands of the chairman of the committee, Mrs. Christine Ladd Franklin, 527 Cathedral Parkway, New York, by the first of January of each year.

Section F of the American Association for the Advancement of Science will hold one session at Cleveland for the address of Vice-president Nachtrieb. All papers will be referred to the program committee of the American Society of Zoologists, and will be read by title only if there is not time for presentation at the announced meetings of that society. Titles and abstracts should be sent to Professor W. C. Curtis, Columbia, Mo., before December 1.

The fourth annual meeting of the American Phytopathological Society will be held in conjunction with the American Association for the Advancement of Science, at Cleveland, Ohio, December 31, 1912, to January 3, 1913. Titles of papers should reach the secretary not later than December 10 to insure their appearance in the society's program. Papers should not require more than ten to fifteen minutes, and in no case exceed twenty minutes, for presentation. Abstracts not exceeding 200 words, and preferably 100, of all papers to be presented should be submitted with the titles, if possible. In order to appear in the official report of the meeting, all abstracts must be in the secretary's hands at the close of the meeting. The pathological exhibition, which was such an interesting and successful feature of the Washington meeting, will be continued at Cleveland. Correspondence in regard to exhibits and space should be addressed to Professor A. D. Selby, Wooster, Ohio. Facilities will be provided for displaying exhibits of all kinds.

The Ohio Academy of Science will hold its annual session at the Ohio State University, November 28–30. The program contains fifty papers. The academy will decide the question of establishing a series of publications which shall include the results of the work done for the Biological Survey of Ohio, which was recently established by the Ohio State University. Several of the colleges of the state are cooperating with the university in making the survey.

The New York State Science Teachers Association will hold its annual meeting in the Central High School, Syracuse, N. Y., on December 26–28, 1912. The sections are: (*a*) Physics and Chemistry, (*b*) Biology and Nature Study, (*c*) Home Economics.

The International Union for Solar Research will meet at Bonn beginning August 1, 1913.

A society for the study of medical history has been established in London as a section of the Royal Society of Medicine. The first meeting was held on November 20.

The fourth Congress of Physiotherapy will be held at Berlin, March 26–30, 1913, under the presidency of Professor His. The principal subject proposed for discussion is the treatment of disturbances of the circulation. The work of the congress will be divided among four sections: (1) hydrotherapy, balneology, seaside and climatic treatment; (2) electro-therapy and radium-therapy; (3) orthopedics, movement treatment and massage; (4) dietetics. There will be an exhibition in connection with the congress.

The tenth International Congress of Agriculture will be held at Ghent next year. The Belgian government and the provincial councils as well as the municipal authorities of Ghent have promised their support to this congress. The various foreign governments have been asked to send delegates. The opportunity of visiting the agricultural exhibition, or "The Modern Village" as it will be called, and the numerous excursions which will be arranged, will make the congress one of special interest. County councils, agricultural societies and colleges, professors of agriculture, farmers, market gardeners and agriculturists generally in all parts of the world are invited to become members of the congress. The reports and proceedings, to be issued in six volumes, will form an agricultural encyclopedia of all subjects of current interest. The congress will meet from the eighth to the thirteenth of June inclusive. Applications for membership, enclosing a money order for 20 francs, should be sent to M. Inspector Vandervaeren, 228, chaussée d'Alsemberg, Brussels. The American committee, so far formed, consists of the following: Dr. L. O. Howard, member of the International Commission on Agriculture and chief, Bureau of Entomology; Dr. A. C. True, director, Office of Experiment Stations; Mr. John Hamilton, specialist in farmers' institutes, Office of Experiment Stations; Dr. C. F. Langworthy, chief, nutrition investigation, Office of Experiment Stations; Dr. J. I. Schulte, assistant agriculturist, Office of Experiment Stations.

The last Congress made appropriations for the U. S. Geological Survey for the fiscal year ending June 30, 1913, as follows:

Topographic surveys	$350,000
Geologic surveys	300,000
Mineral resources of Alaska	90,000
Mineral resources of the United States	75,000
Chemical and physical researches	40,000
Geological maps of the United States	110,000
Gaging streams, etc.	150,000
Surveying national forests	75,000

The bill also appropriates $145,000 for printing and binding survey reports, to be expended by the public printer.

The will of the late Catherine E. Beecher, in compliance with the wishes of her husband, bequeaths her estate for the endowment of a department in the Academy of Natural Sciences of Philadelphia to be known as the J. F. Beecher Biological and Anthropological Laboratory. The bequest, with the conditions defined in the will, has been accepted by the academy. The estate is to be kept intact for ten years before the income is available for the designated purpose.

Among the geological and mineralogical collections of the United States National Museum is an odd boulder of solid copper, known as the Ontonagon Boulder, which has a very interesting history. This large mass of copper has been in the possession of the Smithsonian Institution since 1860, and has recently been moved to the new museum building, where it is now on exhibition in the southeast corner of the east hall on the second floor. The boulder has the appearance of a dull bronze-colored rock, much chipped and worn. It is 3½ feet long, 3 feet wide and 1½ feet in its thickest part, and owing to the great density of copper, weighs nearly 3 tons, a large weight for such a relative small bulk. For ages this remarkable mass of copper lay on the west bank of the Ontonagon River in the upper peninsula of Michigan, where it was known for many years by the Chippewa Indians of that region. It was not until 1766, however, that the first white man, Alexander Henry, an English adventurer and trader, visited this remarkable specimen. During the next 75 years many explorers and scientists followed Henry's footsteps until the boulder became well known as a mineralogical curiosity. It was undoubtedly a valuable specimen worth several thousands of dollars, but its weight prevented any one from making away with it. In 1841, Julius Eldred, a hardware merchant of Detroit purchased this copper rock from the Chippewa Indians on whose lands it was located, and two years later, after many difficulties, succeeded in transporting it down the Ontonagon River, through Lake Superior to Sault Ste. Marie, and thence to Detroit, where it was placed on exhibition for a brief period. Soon after its arrival, the government claimed it, and towards the end of 1843 it was shipped to Washington and deposited in the yard of the Quartermaster's Bureau of the War Department, where it remained until 1860, when it was transferred to the Smithsonian Institution. Some years later the government repaid Mr. Eldred for his time and energy in securing this boulder, congress having appropriated the sum of $5,664.90 for his relief. This specimen represents the first considerable quantity of copper from the Lake Superior region, a district which has since become one of the important copper-producing regions of the world. It undoubtedly came out of the adjacent copper-bearing rocks, and was probably transported southward a short distance during the Glacial Period in the Glacial drift which now covers that country. The museum specimen, though large and interesting, is not by any means the largest solid piece of copper ever found. Copper masses of immense size are encountered from time to time in the mines of Lake Superior, and the largest recorded was found in 1857 in the Minnesota mine. It measured 45 feet in length, 22 feet at its greatest width and more than 8 feet at its thickest part, and contained over 90 per cent. pure copper. The total weight was about 420 tons.

THE *Observatory* gives the following from the *Daily Chronicle*, a leading London paper:

Actors and others are discussing what they shall do with the seventh day. There is a tiny island in the South Pacific where there is no seventh day, six days being the allotted span of every week. All travelers know that time is lost or gained in traveling east or west, and Chatham Island is just on the line of demarcation between times and dates. To keep in line with the almanac, therefore, the plan has been adopted of jumping the afternoon of one day and the morning of the next in every week, so that the islanders commence Wednesday, but at 10 o'clock switch on to Thursday afternoon.

UNIVERSITY AND EDUCATIONAL NEWS

THE children of the late James Dwight Dana (Silliman professor of geology at Yale University from 1850 to 1895) have offered to establish a fund which shall ultimately reach $24,000, the income to be used "to further study and research in geology."

BY the will of Frederick Blanchard of Tyngsboro, Harvard University receives for the use of the Museum of Comparative Zoology his entomological collection.

MRS. JOHN JOSEPH ALBRIGHT, of Buffalo, a trustee of Smith College, has given $60,000 toward the million-dollar fund. This gift is to establish what will be known as the S. Clarke Seelye professorship. The subscriptions now amount to about $500,000.

THE corporation of Yale University has passed a statute regarding sabbatical years, making it possible for a professor or assistant professor to take a half-year's absence on full salary as an alternative for a full year at half salary. A similar plan was adopted by the trustees of Columbia University several years ago.

ENROLLMENT figures for 1912–13 for all departments of Western Reserve University are announced this week at the university as follows: Adelbert College, 456; the College for Women, 354; the Graduate School (incomplete), 14; the Medical Department, 168; the Law School, 130; the Dental School, 127; the Library School (incomplete), 50, and the School of Pharmacy, 111. The total enrollment for all departments is 1,410. Western Reserve University, in its undergraduate departments, Adelbert College and the College for Women, has decided that, under ordinary conditions, no division of a class for recitation purposes is to exceed twenty-five persons. This vote, applying to all classes, means that in the freshman class of Adelbert College there will be seven divisions, and in the freshman class of the College for Women five divisions in all required subjects. Many large elective classes will be divided into two, three or four divisions.

DR. FRANK PELL UNDERHILL, assistant professor of physiological chemistry in the Sheffield Scientific School, Yale University, has been elected professor of pathological chemistry in the Medical School.

PROFESSOR R. C. PUNNETT has been appointed the first Arthur Balfour professor of genetics at Cambridge University.

DISCUSSION AND CORRESPONDENCE

RADIOTELEGRAPHIC ACHIEVEMENTS BY THE POULSEN SYSTEM

TO THE EDITOR OF SCIENCE: I wish to call attention to the important results being accomplished in this country by the Poulsen system of wireless telegraphy. This system and the work that is being done by it is of great scientific interest as well as practical importance, and inasmuch as almost nothing is generally known about it a brief account of its main features may be of interest to the readers of SCIENCE. Although not a physicist I am led to call attention to this subject because I have waited in vain to see any mention of it in scientific journals, and because numerous students of related subjects whom I know have failed to take much interest in it. This lack of interest is apparently due to the prevailing prejudice against the claims of wireless telegraph companies in general.

The system of wireless communication in question is that invented by the Danish scientist Valdemar Poulsen, and is radically different from the Marconi and related spark systems. Instead of intermittent waves such as are sent out by the spark system, the Poulsen system sends undamped continuous waves by means of an arc. In transmitting a message the signals are given not by interrupting the current but by slightly varying the wave-lengths in a continuous wave train. Experience is proving that such continuous wave trains are far less affected by adverse atmospheric conditions and other obstacles, and are propagated long distances with much less power than the broken waves sent out by the spark system, and that they possess numerous other advantages. As a result, entirely reliable communication for long distances over land, and communication by day almost as well as by night, is made possible.

The greatest advances in the development of this system are being made in the western part of the United States, largely by persons now or heretofore connected with Stanford University. Stations ranging in power from 5 to 30 kilowatts are in operation in the large cities on the Pacific Coast, from Seattle to San Diego, and at Phœnix, El Paso, Fort Worth, Kansas City and Chicago. Telegraphic messages are being transmitted constantly, day and night, along the Pacific Coast and as far east as El Paso, and messages are sent from there by night to and from the comparatively low-power stations so far installed at Fort Worth, Kansas City and Chicago. Since the recent establishment of a 30-kilowatt station at San Francisco with two 440-foot towers it has been found possible to send messages direct from the coast to Fort Worth and Kansas City, and do away with the intermediate relays. Within the past few weeks a station has been completed at Honolulu and every day from 1,000 to 4,000 words of news and private messages are sent thither by the San Francisco station. This news appears in the Honolulu daily paper and, by virtue of its cheaper cost than news by cable, is affording the people there for the first time complete news of the world each day. This distance is more than 2,350 miles and is the longest over which continuously successful wireless communication has ever been established. Furthermore it is the longest single span of ocean necessary to cross in circling the globe, and forecasts trans-Pacific wireless communication in the near future. The power used at these Pacific coast stations is only a small fraction of that necessary for sending messages by the spark system across the two thousand miles of ocean from Ireland to Nova Scotia.

With the aid of mechanical transmitters and receivers from 100 to 300 words per minute are accurately sent and received by the Poulsen system over distances of several hundred miles, and a method has been devised whereby two messages can be sent or two received simultaneously over the same antenna. The wave-lengths can be readily varied, and, as each station has its assigned wave-length to which it keeps its receiving apparatus attuned, messages can be sent to any point desired without troubling other stations. Or, if desired, all stations within range can receive the same message simultaneously. Messages sent by the Poulsen system are not read by operators of other systems and the stations do not experience the interference from outside operators which is so troublesome a feature of the spark stations.

In addition to telegraphic communication the Poulsen system has been proved successful for wireless telephony. I can personally attest the simplicity and clearness of this method of transmitting speech, having telephoned more than two years ago between Stockton and San Francisco, a distance of 80 miles over land. Subsequently speech has been carried in this way from San Francisco to Los Angeles, 450 miles, but as yet no thorough tests have been made of the system's telephonic possibilities, attention having been concentrated upon the telegraph.

There are other novel and important features of the Poulsen system which it would take too long to mention. As yet only a beginning has been made in developing its possibilities. The next step will be to test and put in use generators of increasing powers, from which increasing ranges are expected. The success so far attained has advanced the science of communication considerably beyond its generally recognized limits, and affords sound basis for the expectation that a few years will see much of the present work not only of ocean cables but also of long distance telegraph lines done by undamped electromagnetic waves transmitted through space.

Robert Anderson

Washington, D. C.,
November 6, 1912

PICTURES OF PSYCHOLOGISTS

Having the Open Court series pictures of psychologists and philosophers, I have often wished that I had those of present-day psychologists on the walls of my recitation room. I have often thought of writing to psychologists for their photographs, but that would be a good deal of trouble and if a number followed that plan it would become a nuisance to those whose pictures were most desired. A continuation of the Open Court series would be desirable, but who is to decide which of the living men should be included and would not such a series be unprofitable because of its inclusions and omissions?

The following plan occurs to me as a means of getting what is desired without any of the above disadvantages. Let those desiring photographs name the ones whose pictures are desired to the one who is willing to take charge of the matter. That one can then procure one photograph of each person named and have a plate made from it of the same size as the Open Court series and arrange with a photographer to furnish photos from these plates at a reasonable rate.

Are there enough who desire such pictures to make it worth while to inaugurate the plan? This can be answered if all who are interested will at once write to me signifying their desires and naming at least a few of the men whose pictures they wish. Prominent educators and perhaps other men of science might be included if they were asked for. If interested do not fail to write at once.

E. A. Kirkpatrick

Fitchburg, Mass.

SCIENTIFIC BOOKS

The Spider Book. A Manual for the Study of the Spiders and Their Near Relatives, The Scorpions, Pseudoscorpions, Whipscorpions, Harvestmen, and Other Members of the Class Arachnida, Found in America north of Mexico, with Analytical Keys for Their Classification and Popular Accounts of Their Habits. By J. H. Comstock. Garden City, New York, Doubleday, Page & Co. 1912. Pp. xv + 707; 771 figs.

This work, the most recent of the series of well-known nature books published by Doubleday, Page & Company, fills a long-felt need, since the spiders are the most abundant and conspicuous representatives of a large group of organisms, which have never aroused an interest, in the American student at least, at all commensurate with their biological and economic importance. The author has arranged the vast amount of material, which he has accumulated during more than a decade of enthusiastic study, in conformity with the plan adopted in the preceding volumes of the series, throwing the emphasis on the classification and subordinating the morphological, ethnological and chorological data to this arrangement. By way of introduction to the main subject of the volume the various lower groups of Arachnida are briefly discussed. This portion of the work, apart from the useful tables for identification, does not rise above the level of many zoological text-books, and some of the sections, as, *e. g.*, those on the ticks and mites, scarcely do justice to our present knowledge or to the economic importance of the subject. The account of the spiders, which are, after all, *the* subject of the book, is preceded by chapters on their external and internal anatomy and their behavior. The anatomical treatment is detailed and comprehensive but, except for a careful description of the male palpus, contains little that is new. Professor Comstock's study of the palpus forms a small treatise in itself and constitutes a valuable contribution to our knowledge of a peculiarly intricate mechanism. The spinning glands are also discussed in considerable detail as the author has been much interested in the construction of the web, a subject fully treated in his account of the "life of spiders," to the neglect or abridgment of many other equally interesting habits in these solitary organisms. No general account of the geographical distribution of the nearctic species is attempted, although such an account would have been very timely and of great interest to many zoologists who are not arachnologists. The systematic descriptions of the genera and species, and especially the tables for their identification, which occupy three fourths of the volume, are extremely valuable. The species are adequately illustrated from photographs or drawings of living or recently killed specimens, with their webs, nests, details of anatomical structure, color patterns, etc. Most of the figures have been well reproduced, but in some cases the fine photographs have suffered the customary deterioration in the hands of the engraver and printer. These are, of course, not the faults of the author, who deserves the hearty congratulations and thanks of all American zoologists for having given them such a helpful and beautiful volume.

W. M. Wheeler

Duc d'Orléans. Campagne Arctique de 1907. Annélides Polychètes par Pierre Fauvel, iv, 45 pp., 4°, 2 pl.; Crustacés Malacostracés, par le Dr. Louis Stappers, xxiv, 152 pp., 4°, 7 pl., 2 charts. Imp. Sci. Bruxelles, 1911.

The annelid fauna of the Arctic seas being practically circumpolar, and investigated in much detail by the Scandinavian and German naturalists, it was hardly to be expected that the expedition of the Duke of Orleans on the *Belgica* in 1907 would add many novelties. As a matter of fact *Sphærodorum philippi* Fauvel was the only new species among the sixty-two collected on the coasts of Novaia Zemlaia, the Murman, Kara and Polar seas. Valuable notes as to the distribution, and data on the organization of several little-known forms, and a useful bibliography of work on Arctic annelids ensure a welcome for the memoir.

The sea north of Siberia has been but partially explored for Crustacea, and Dr. Stapper's collection, in spite of the adverse circumstances attending work in ice-encumbered waters, comprised no less than ninety-four species, of which two amphipods, one isopod and two sympods proved unknown to science.

Many of the species collected were obtained in considerable numbers, which permitted dissection of numerous individuals. The exact data as to distribution in depth and geographic range render the records of the collection especially valuable to science, and the twelve pages of bibliography will prove a boon to students. The execution of the plates as usual with this series of reports leaves nothing to be desired.

Wm. H. Dall

Beyond War: A Chapter in the Natural History of Man. By Vernon L. Kellogg. New York, Henry Holt and Company. 1912. Pp. ix + 172. $1.00.

A biologist's contribution to the literature of the peace movement. The argument of the book runs somewhat as follows. "Man" is, like any organic species, a stage in evolution, an organism with a past and with a future. Human nature, like Nature herself, is not immutable, but inevitably mutable. Characteristics possessed at one time by the supra-modal few come to be possessed by the mode, and in passing are represented, for a time, only in the sub-modal group. War is such a trait—now vestigial, not rudimentary—an anomaly and an anachronism; it will disappear from human life when the mode of the species is well beyond war. When the facts of man's whole history are brought into line, one can, sighting along it, see that his evolution is clearly to be away from war. Like an organic species, war is a species of conflict and it will give place to other forms of conflict, no less real but more humane.

To many scientific readers the most valuable part of this book will prove to be the convenient summary of man's physical and mental evolution during quaternary times, contained in Chapters II–V. Here are presented, in Professor Kellogg's well-known, striking style, and in a form well adapted for the general reader, the evidence for the existence of Tertiary man, and brief characterizations of early Quaternary man—"Homo Primigenius: Man of the Great Ice"—who found in fighting his chief occupation and diversion. "Homo Priscus: Man after the Ice," partially freed by his wit from constant struggle with the rest of nature, devotes some of his newly acquired leisure toward fashioning his own environment.

Neolithic man, "Homo Sapiens: Man of History," gets something to call "culture." He begins to experience the results of his own modification of his environment, and finds that he has inherited not only instincts and reflexes, but also the capacity to modify these by the exercise of reason; and so he begins to take a hand in directing the evolution of his "human nature." Kellogg recognizes the proximity of this idea to the "inheritance of acquired characters," but proceeds. Man of to-day, as an individual, fights as a pastime chiefly, and international war has become primarily a struggle to destroy dollars. The real desire for war occasionally is said to be already a sub-modal species character.

As to Quinternary man, "Homo Superioris: Man of To-morrow," Kellogg ventures to prophesy, saying that his physical constitution seems fixed and unlikely to be much further changed, and he must perforce depend for his existence upon the evolution and use of his intelligence. As this develops man will recognize the truth about war and will, must, eliminate it from the species life.

It is obviously possible to arrange the leading facts of man's evolutionary history so as to indicate the future elimination of war, and, faith being the substance of things hoped for, let us have faith that this prediction may be speedily fulfilled. But that one may also arrange the facts of man's whole history, as well as of man's History, so as to point in any direction hoped for, is still true; and many of Kellogg's theses might serve as subjects for argumentation.

"Beyond War" is a clear indication of the now recognized necessity of enlarging history to include the whole history of man and his works, and of the important relation of biological facts to the work, not only of the historian, but of the politician, the economist, sociologist, philanthropist and peacemaker. While our biological substructure may not yet be able really to bear the load often thus placed upon it, we should and do welcome heartily every attempt of the trained biologist to make his science available for use and for human life.

Wm. E. Kellicott

BOTANICAL NOTES

THE BRUSSELS CODE

It may now be well in the middle of the lustrum between the Brussels Botanical Congress (of 1910) and the London Congress (to be held 1915) to make some pronouncements upon what progress has been made towards securing a useful and workable code and what remains yet to be done. Before the Vienna Congress (in 1905) there was great diversity of practise among botanists, and not a little heat and temper had been displayed by the champions of this or that particular view. When Otto Kuntze about twenty years ago stirred up the whole subject there were many who regarded his action as wholly unnecessary and uncalled for, and yet it is true that from this stirring up of things have come the two congresses, namely, at Vienna, and Brussels, and much that Kuntze contended for has now been enacted into botanical law. So too, the movement in America a little later, culminating in one or two published "codes," served to accentuate the demand for a more general agreement as to what should be good botanical practise.

Most botanists have had in hand for about three months Briquet's report and compilation of the code as modified by the Brussels congress, and they have had time to consider the wisdom of the more recent changes and additions, and the adequateness of the code as a whole. In considering this code we must not overlook the fact that we have secured the recognition of our chief contention, namely, the "law of priority." So too we have secured the recognition of the necessity for a *beginning date* for nomenclature. And today the original name of the species is preferably retained, whatever generic wanderings it may suffer, and a name which has become a synonym can not be used for another plant. Even in regard to publication and the use of parentheses the essentials that we contended for have been enacted into law. Only in regard to the use of specific names which repeat the generic name does the new code run counter to the practise of many American botanists, and it must be said for this latter point that few of us would care to insist strenuously upon the acceptance of our practise.

So we have succeeded in having most of what we demanded included in the botanical code, but as always happens when legislation is had, some things have been added that are not at all to our liking. Thus with the underlying principles (Arts. 1 to 18) no fault need be found, but in our opinion the Brussels congress made a series of blunders in Art. 19, when it selected the starting points for the nomenclature of various groups. In fact here there was evidently a hopeless confusion of "starting points" with complete monographs, resulting in the designation of not less than twenty different dates, in eight publications, with at least four more groups still to be heard from. When it is suggested that the point of beginning for some algæ is 1753 (Linne's "Sp. Plant."), while for others it is any place from 1891 to 1893, and for still others 1886, and for others again 1848, while for one little family (*Oedogoniaceae*) it is as late as 1900, it is pretty evident that the law makers forgot what they were doing. This matter of starting points for nomenclature will have to be revised by men who can "keep their heads"!

Then while the law of priority is sanctioned (Art. 15) the vicious practise is enlarged of making exceptions (*nomina conservanda*) of names that are to be retained in spite of the law. Such "special legislation" reminds us of what political legislatures sometimes do when exceptions are made in favor of "special interests," but certainly such things ought not to be done by a body of scientific men. The Brussels Congress augmented the lists of *nomina conservanda,* and in doing so showed more forcibly than at Vienna that the lists have no scientific basis, but that they rest upon the prejudices and preferences of a few botanists who object to the use of unaccustomed names for certain plants. Prejudice and individual preference have no rightful place in determining scientific nomenclature. One is inclined to quote here the final article (58)—"The rules of botanical nomenclature can only be modified by competent persons at an international congress convened for the express purpose," and to make the very obvious remark that it may be questioned whether all of the work before us was done by "competent persons." In the opinion of the writer this question must be answered in the negative for some parts of the code.

Now, what shall we do in regard to this code? There are those who boldly say that a code so drawn up should not be obeyed, and accordingly they ignore such of the rules as they do not approve. And the temptation to do so is very great, especially in regard to the starting points of nomenclature, and the *nomina conservanda,* but we are convinced that the wiser policy will be to accept the code as a whole, and obey its dicta. Of course it is never an agreeable thing to have to do what our judgment disapproves, but the only way that we can make progress is to submit to the code as it is, with the determination, that we will bring about the desirable revisions and changes as rapidly as possible. So we conclude that, disagreeable as it may be, it is the best thing for the science that we should obey the rules of the code.

CROWN GALL AND CANCER

Attention should be called again to Dr. E. F. Smith's suggestive paper "The Structure and Development of Crown Gall: A Plant Cancer,"[1] issued June 29, 1912. In its preparation the author was assisted by Nellie A. Brown and Lucia McCulloch, scientific assistants. As expressed by Dr. B. T. Galloway in his letter of transmittal to the Secretary of Agriculture:

This paper is the result of many months of critical study of hundreds of serial sections prepared on the microtome; and so far as relates to the photographic demonstration of the presence of the causal organism within the proliferating cells, to several years of laborious and discouraging experimentation with a variety of fixing agents and stains. Only recently has it been possible to demonstrate clearly by means of the microscope the presence of the parasitic organism within the cells, although the authors have known for more than five years that this organism *must be* located within the cells.

Proof of the latter contention having been attained the conclusion is reached that

While it is the rapidly proliferating cancer cells that do the michief they are impelled to behave in this way only because they are under the stimulus of a foreign organism which does not destroy them but irritates them to rapid division.

We can well agree with Dr. Galloway in pronouncing this "a discovery of the first magnitude in pathology."

The paper is accompanied with one hundred and nine "half-tone" reproductions of photographs, often very highly magnified, and these plates constitute the greater part of the evidence upon which the author relies. Among the statements given in the résumé the following may be quoted:

Crown galls occur on a great variety of plants, but not always on the crown; any part of the root or shoot is liable to attack.

Young, well-nourished, rapidly-growing tissues take the disease more readily than old or slow-growing ones.

They are all of parasitic origin, unless the one on the beet studied by Jensen, Reinelt and Spisar, in Europe, should prove an exception.

These galls are due to schizomycetes, either to one polymorphic species, or to several closely related species. Further studies are necessary.

The parasite has been shown to occur not only in the primary tumor, but also in the secondary tumors and in the connecting tumor strand.

The tissues of the gall multiply excessively and in opposition to the best interests of the plant.

The galled tissue, which is often of a soft, fleshy nature, is much subject to decay. It is not usually corked over, and this absence of a protective surface allows the ready entrance of water and of other parasites.

The tumor originates in meristem, usually in the cambium region. It may perish within a few months or continue to grow (parts of it) for years.

The tumor consists, or may consist, not only of parenchyma cells but also of vessels and fibers, *i. e.*, it is provided with a stroma which develops gradually as the tumor grows.

The tumor sends out roots (tumor strands) into the normal tissues. These may extend for some distance from the tumor—how far is not known. These strands consist of meristem capable of originating medullary rays, tracheids and sieve tubes.

The stimulus to tumor development comes from the presence of the parasite within certain of the cells.

The relation between the host and the parasite may be regarded as a symbiosis in which the parasite has the advantage.

The bacterium is a soil organism and planters should aim to keep their lands free from it by refusing to plant infected stock.

The organism is a wound parasite. Its entrance is favored by careless grafting and by the presence of borers, nematodes, etc.

Nothing in this bulletin should be construed as indicating that we think the organism causing crown galls is able also to cause human cancer, but only that we believe the latter due to a cell parasite of some sort, and offer the preceding pages in support of this contention.

Charles E. Bessey
University of Nebraska

[1] Bull. 255, Bureau of Plant Industry, U. S. Dept. Agric.

THE ANALYSIS OF NATURAL SELECTION[1]

The actual operation of natural selection is rarely investigated. The various methods that have been employed will be here considered seriatim, in order that their advantages and limitations may be noted.

1. The comparison of the mean magnitude of the characteristic in question in those individuals that died either with that of the survivors or with that of the whole number. This method is simple and where the difference is considerable does provide proof that secular[2] natural selection was operative. Its shortcomings are that it furnishes no analysis of the operation of selection and that periodic[3] natural selection is not detected by it.

2. The index of correlation between the length of time of successful resistance to the adverse condition and the magnitude of the characteristic in question. This method has been used by Dr. F. E. Lutz on *Ampelophila.* In addition to demonstrating the action of natural selection, it may in some cases, as in *Ampelophila,* throw valuable light on the action of the cause of death. Its limitation is its failure both to discriminate between periodic and secular selection and to analyze the distribution of the incidence of natural selection.

3. In addition to comparing the means of the individuals that perished and survived, Bumpus, in his well-known sparrow observation, compared the extremes with the whole number, in this way being able to detect any periodic selection that may have taken place, as well as the secular selection. This method, too, falls short, because a still closer analysis is desirable, and because the result hinges on the particular choice of the percentage of the whole chosen to represent the extreme.

4. We have a further step in analysis in Weldon's method of showing the results of his classic experiment in subjecting *Carcinus* to clay suspended in water. Here the polygon of the perished is superimposed upon the polygon of frequency for the whole number. The eye can then wander along the polygons and observe the relation of the two throughout their courses, which makes a fuller analysis possible. But in making the analysis the mind must compute the ratio for each class as best it can.

The method which I wish to propose determines these ratios precisely and plots them graphically. The survival rate is determined for each class, and plotted, preferably superimposed upon the polygon of frequency of the whole number, so that the numbers used are shown. Since the probable error of the survival rates increases towards the extremes where based upon fewer individuals, some method of combining classes is frequently desirable. Only such combining should be done as is considered absolutely necessary, because the analysis is less discriminative by just so much. The combining may be done by arbitrarily adding the classes in groups of 2, 3, 4, etc., or by combining the most extreme eighth in one direction, the next eighth, and so forth. This may be done absolutely, or in some cases, to the nearest class. The particular method depends largely upon the number employed. Rougher grouping and a larger number of classes are permissible where there are large numbers. In Fig. 1 I have applied the method to Weldon's experiment with crabs (male *Carcinus mœnas*) in muddy water. The survival rate is determined for each class and a survival curve thus established. It will be seen that, even with this large number of classes, the curve is clearly inclined. In Figs. 2 and 3 I have replotted the curve in four and eight classes, respectively, of about equal numbers to smooth out the irregularities arising from the small numbers in the extreme classes. With so active a natural selection, one can well believe that, in spite of the criticism of Cunningham, there actually took place in nature the evolution shown by the statistics gathered in the successive years of the crabs at Plymouth.

[1] This article was written while the author was on the staff of the Station for Experimental Evolution at Cold Spring Harbor, N. Y., of the Carnegie Institution of Washington.

[2] Pearson's term for the form of natural selection which favors one extreme over the other.

[3] Pearson's term for the form of natural selection which favors the mode at the expense of the extremes.

The numbers are smaller in the widely quoted observations of H. C. Bumpus on the sparrows which survived in a lot that were picked up after a severe storm at Providence, R. I. By using only four classes, however, the survival curve is so inclined that we may safely draw conclusions. The conditions in

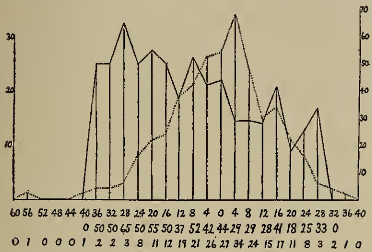

Fig. 1. The polygon of frequency of the frontal breadth (dotted line) of *Carcinus mœnas* in Weldon's experiment, with the survival rate (solid line). First line of numbers, deviation; second line, survival rate; third line, numbers.

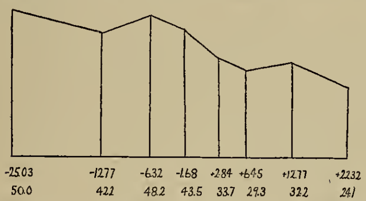

Fig. 2. The survival polygon in the Weldon crab experiment plotted in eight classes. First line of numbers, deviation; second line, survival rate.

this study probably do not show the full selective effect of the catastrophe, for we here contrast those which perished with the disabled which survived when protected. The sparrows which had succeeded in finding suitable shelter would probably have shown a still greater difference from those that died, could they have been obtained. Bumpus confined himself to a study of the absolute measurements, but since there was a selection as to the size of the birds (Fig. 4) I have reduced the other measurements to percentage of length. The result shows a much greater influence of selection than that shown by the absolute measurements. The selection is also seen to be secular (Fig. 5) rather than periodic, as Bumpus concluded from the absolute measurements. The survival curves are shown for the

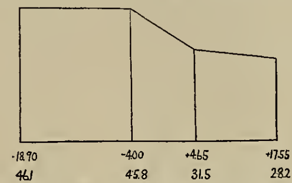

Fig. 3. The survival polygon in the Weldon crab experiment plotted in four classes. First line of numbers, deviation; second line, survival rate.

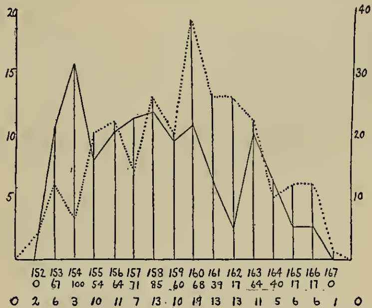

Fig. 4. The polygon of survival rate of the length in the Bumpus sparrow case. First line of numbers, length in millimeters; second line, survival rate; third line, number of individuals.

sake of direct comparison in one diagram, using as ordinates the average of the respective classes.

Curiously enough, while the males show a well-marked secular selection in the same direction in each measurement, the females are either only slightly secular or indifferent. In some cases, like the measurements of the femur and humerus of the males, the differences are very great, all of the longest fourth

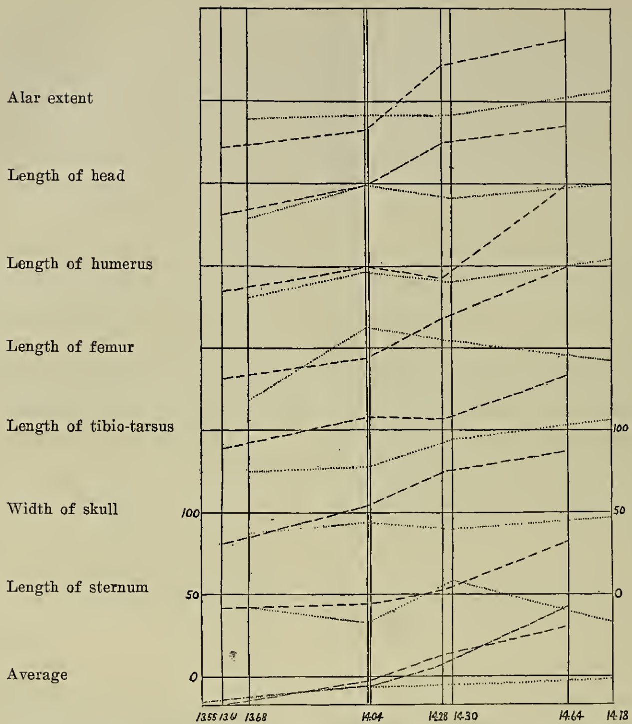

Fig. 5. The survival polygons of the measurements expressed in percentage of length in the Bumpus sparrow case. Dash line, all males; dotted line, females; dot and dash line, young males. The horizontal line opposite the name of each dimension represents 50 per cent. survival, the next horizontal line below 0 and the next above 100. Numbers at bottom are the average dimensions of the four classes.

(divided to the nearest class) surviving. Bumpus had based his conclusions on the very few extreme individuals, instead of the two extreme fourths. I believe this is dangerous, on account of the small numbers, but for comparison, I have also plotted the extreme classes. To avoid the danger of small numbers, I have combined the extremes in all six characteristics, since the survival curves have a common inclination. Here also the result (Fig. 6) shows secular and not periodic selection. Bumpus was led to his conclusion from the fact that in length there is some degree of periodic selection as well as secular selection shown (Fig. 5). Even in length the small numbers involved in the end classes cast some doubt as to their significance. Taken as a whole, therefore, I believe this sparrow catastrophe reveals very much more secular than periodic selection, if there be any of the latter, although very naturally the experiment has been quoted to show periodic selection in the literature of evolution, where it has figured so largely.

Fig. 6. The survival rate in the extreme cases in the Bumpus sparrow case to test periodic selection. The rates plotted are the rates made up by averaging those for the corresponding extreme classes of all the dimensions, each expressed in percentages of length. First line of numbers, the extreme classes; second line, survival of females; third line, survival of males.

The weight of the sparrows shows a secular selection in a negative direction, but in percentage of length, the selection seems indifferent.

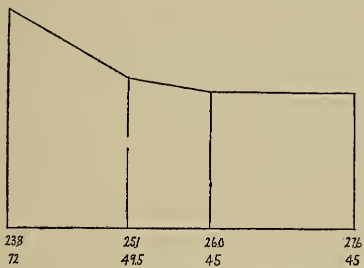

Fig. 7. Survival polygon for weight in the Bumpus sparrow case plotted in four classes. First line of numbers, weight in grams; second line, survival rates.

The selection in absolute weight, therefore, is due to the correlation with length which is selected. For this reason and because it is not a dimension, I have not plotted it with the other characteristics (Figs. 7 and 8).

The application of this method to Cramptou's observations on the length of antennæ in female pupæ of the moth *Philosamia cynthia,* is shown in Figs. 9 and 10. This shows clearly the amount of selection and brings out the fact, which is otherwise overlooked, that

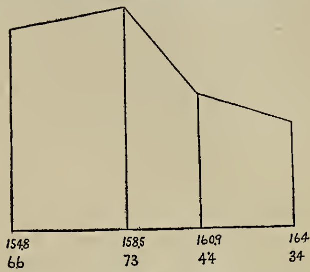

Fig. 8. Survival polygon for length in the Bumpus sparrow case plotted in four classes. First line of numbers, length; second line, survival rate.

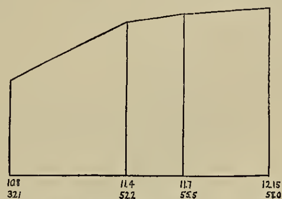

Fig. 9. The survival polygon of the length of left antennæ in female pupæ in Crampton's experiment plotted in four classes. First line of numbers, length of antenna in millimeters; second line, survival rate.

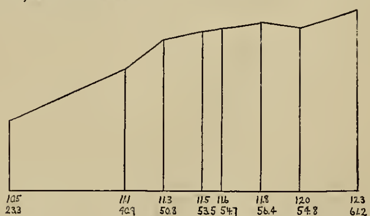

Fig. 10. The survival polygon of the length of left antennæ in female pupæ in Crampton's experiment plotted in eight classes. First line of numbers, length of antenna in millimeters; second line, survival rate.

the rate of survival changes most rapidly with the shorter antennæ.

Dr. Robert W. Hall and I have submitted *Palæmonetes vulgaris* to changed salinity. Figs. 11 and 12 show that where the marine shrimps were placed in fresh water, the survival curve is higher for those of few rostral spines. Few spines is the normal condition in the fresh water species. The brackish-water strain of the marine species has also fewer spines than the typical marine species. When some of these brackish water shrimp were subjected to brine the survival curve was higher for the larger number of spines; that is, higher for the marine conditions. The difference in the former case not being well marked, the experiments should be repeated on a larger scale and with greater refinements, before drawing definite conclusions. In the latter case, however, the result clearly shows selection.

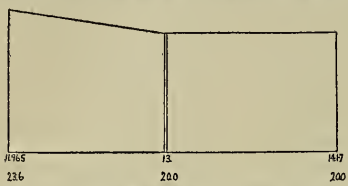

Fig. 11. Survival rate in Johnson and Hall experiment in exposing shrimp from marine salinity to fresh water. First line of numbers, number of rostral spines; second line, survival rate.

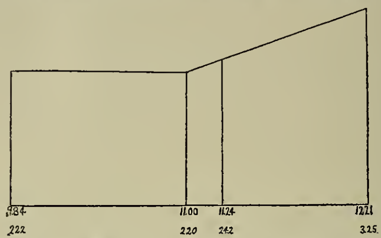

Fig. 12. Survival rate in Johnson and Hall experiment in exposing shrimp from brackish water to brine. First line of numbers, number of rostral spines; second line, survival rate.

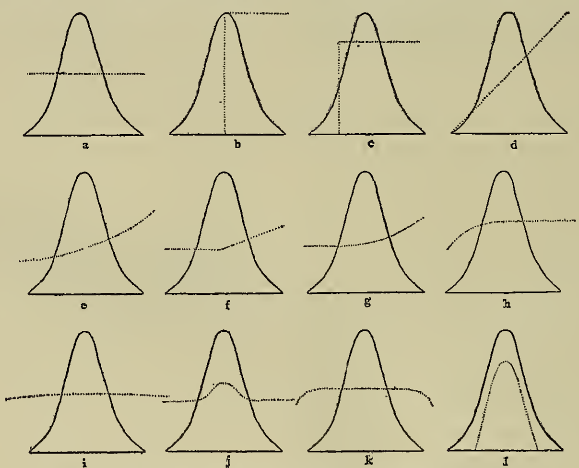

Fig. 13. Various theoretical survival curves (dotted) plotted upon a theoretical polygon of frequency.

In the use of the method in actual cases, the scale is of definite quantities. For theoretical purposes, we may plot survival on a vertical scale from 0 to 2. In this case 0 means no survival, *i. e.*, all individuals in the specified class died prematurely. At 1, we have one individual attaining the age of reproduction for each corresponding parent. At 2 we have two progeny attaining maturity for each corresponding parent. Now if the survival line is level (Fig. 13*a*) natural selection is not active; but if it be in any degree inclined (Fig. 13*d*) natural selection is in operation. Figs. 13*b*, 13*c* and 13*f*, I have drawn the survival curve as one would expect it from some descriptions of the action of natural selection, but such abrupt changes in the survival rate must be decidedly exceptional. The actual line is ordinarily a gentle curve, the survival rate always being low and gradually becoming lower or higher from class to class, as in Figs. 13*d*, *e* and *g*–*l*. The periodic selection where the species is kept stationary is illustrated in Figs. 13*i* to 13*l*. There is every gradation of course between this and secular selection. The point to which selection would carry the species might be close to the present mode.

The survival curve, if we had the data to construct it for a sufficient length, would probably, in many cases, especially those involving measurements, touch 0 in one direction and some low value in the other direction, and at some point between rise to a point or become level as in Figs. 14*b* and 14*c*. In the case of Fig. 14*c*, the species will evolve until selection becomes periodic, but in Fig. 13*b* we have a different condition. Here it is carried to a point where natural selection becomes impotent. It is in such a case that determinate evolution has free play and may, in some cases, carry the species further. In still other cases there is an absolute limit of variation in the characteristic; for instance, blackish color would have a limit at absolute black (Fig. 15*b*). In such a case the survival curve would come to a sudden stop on the particular rate for that point. If the inclination is upward

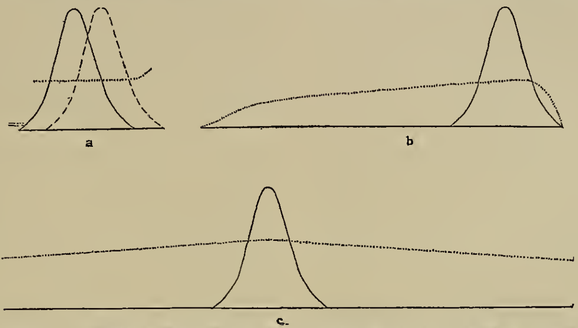

FIG. 14. Theoretical survival curves. Dotted line, survival rate; solid line, theoretical polygon; dash line, polygon of frequency of young individuals.

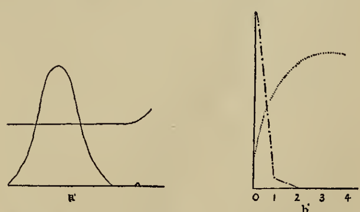

FIG. 15. (*a*) Theoretical survival curves with the mutation alone affected by a differential survival rate. (*b*) The polygon of frequency and of survival rate are limited in one direction.

toward the limit, the species must remain at the limit.

The process of natural selection must be further analyzed because of the heterogeneity of the species. A species is made up not only of individuals of two sexes in most cases, but also of individuals of various ages. This difference may affect the survival results in two different ways. The individuals of one sex may differ quantitatively so that they will be affected by differing survival rates when survival is discriminative. Because of the sexual difference, Weldon in his *Carcinus* experiment used males only, in order that it might not be necessary to increase the number to be measured.

At different ages, natural selection must often operate differently, for the characteristic changes quantitatively, and sometimes qualitatively, with age. Where the change is quantitative, the individual will change in its survival chance, where survival is discriminative. Where the change is qualitative the characteristic in question may only be in evidence during part of the lifetime. In addition to this, the survival chance may change with age, regardless of the magnitude, because of the general inefficiency of the immature. In many species, the rigor of natural selection is doubtless concentrated on the younger stages, with much decreased action later. Specific instances we have in the vital statistics of man, and in the large birds of prey, where they are not molested by man.

In experimental work, economy of effort demands concentrated attention upon adults only or upon the young of some restricted age group. Nevertheless, such a study has a serious limitation, for the whole influence of natural selection upon a species can not be known until we have an analysis of its action for every age group in the species. While the number of young individuals in the sparrow experiment of Bumpus was too small to permit an analysis along age lines, yet inspection shows that the selection was affected by age. It is quite probable that where natural selection is inoperative upon adults, it may be very efficient in some younger stages. In Fig. 14*a* I have illustrated the escape from the incidence of natural selection by age. Crampton's results with the antenna lengths of *Philosamia pupæ* might not be found to apply in imaginal life. In fact, we have the possibility that natural selection might be nullified by a reversal of action in the adult from its action at some younger stage. Thus an extra abdominal segment might be favored in the caterpillar, but penalized in the moth. Such a disparity has the effect of making the young different from the adult, ending in some cases in an elaborate metamorphosis.

It would seem that a polygon of frequency would move along a survival curve based upon the measurement of some one character until it reaches its summit, when it would remain stationary. Periodic selection would then ensue. This maintains the species at a fixed point and decreases variation. One might at first suppose that when a new structure begins, the survival curve would start at 0 and move along with the increase of the structure to a maximum. But it must be remembered that this is impossible, for the height of the theoretical curve must always have an average height of at least one, no matter what the characteristic used in the construction of the curve may be, unless the species is decreasing in abundance. Furthermore, it can get no higher than one unless the population is increasing in numbers. What we really have, therefore, when there is no change in abundance, is a compensatory depression of the whole survival curve, as the frequency polygon moves up its slope. It may be likened to a man climbing a step ladder in a descending elevator. His rate of speed might be such that his elevation would not change, but he would have horizontal motion. In this case, there would be a general depression of the survival curve to compensate for the increased survival from the increase of the characteristic in question. Elimination would necessarily become sharper at some other point, the weakest point, or at several weak points. But the elimination, discriminative with respect to this second weak characteristic, would with the first characteristic be generally distributed, and so cause the general depression of its survival curve. For instance, let length of feather have a differential survival value, when a species of sparrow encounters colder winters. Evolution in the direction of increased feather length would cause an increased abundance of the species, unless there was a counter-influence. Such a counter-influence might be a greater mortality from shrikes, as more sparrows would thus come under their observation and engage a larger share of their attention.

The graphic method here proposed is also applicable to mutation (in the De Vriesian sense) though of less value in that connection. In such cases the mutation is plotted on the base line at the appropriate distance from the polygon of frequency and the curve of survival is extended past this point. The curve of survival may be level in the region of the polygon, but inclined outside of it, so as to affect the mutation either favorably or unfavorably (Fig. 15*a*). Or the survival curve may be inclined throughout its course, in which case the mutation does not have an exclusive advantage or disadvantage. Many of the complications referred to before are also applicable here, but further mention will only be made of the case where the survival curve is strongly inclined at the magnitude of the mutation and it is therefore strongly subjected to natural selection within its own unit in addition to its competition with the old species.

Coincident selection, which many zoologists have apparently had difficulty in understanding, is, I believe, made quite clear by the use of this method. I follow Gulick in considering Lloyd Morgan's term of coincident much preferable to Baldwin's meaningless phrase of "organic selection." In expressing coincident selection, it is only necessary to construct with the survival curve two polygons of frequency, one for the innate variation, and the other for the resultant variation after the modification by the environment.

The action of coincident selection will differ in degree according to the type of correlation of the modification with the innate variations. There may be three cases. In the first, the modification is always the same in amount, regardless of the degree of development of the innate character. This results in the transfer of the original polygon of frequency to one side or the other. Since, however, the modification would of course be some-

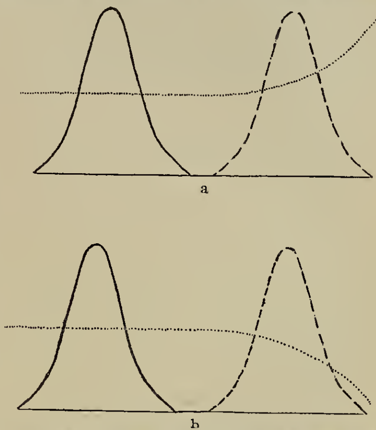

FIG. 16. The dash line polygon represents the individuals in a case of extreme coincident selection after modification. The solid line polygon represents the individuals as they would have been if not modified. Dotted lines are theoretical survival curves.

what variable, there would be some readjustment of distribution, and a corresponding increase of the variability (Fig. 16*a*). This is the case usually assumed in the consideration of coincident selection and its consequences are well known. In Fig. 16*b*, where the modification is opposed by natural selection, it may be expected to decrease in amount. In the second case, the modification is greater in those individuals which have the innate characteristic in a less degree than in those in which it was larger. Thus, elephants with an innately shorter trunk might have greater modification than others because of greater strains involved in its use. The final result in this case, then, would be the shifting of the left end of the polygon of frequency further to the right than the right end would be shifted. This produces a narrowing of the range and decrease of variability (Fig. 17*a*). The result is a decrease of natural selection, unless the survival curve is more inclined at the new position (Fig. 16*b*). In the third case, those with the characteristic in question innately larger sustain the greatest modification. This might be illustrated in the case where only some moths which could reach the nectar of a particular flower would make continued effort to do so. By increasing the range (Fig. 17*b*) an increased efficiency of natural selection is produced, even though the polygon is not transferred to an increased inclination of the survival curve. It is probable that the greatest importance of coincident selection lies in its efficiency to promote incipient organs in this way, for it is easy to see how important it would be in such a case as the transformation of a somewhat prehensile snout to the elephant's trunk. On the other hand, it must, in many cases, slow up the efficiency of natural selection, when an organ has passed the "infant industry" condition, and thereby enters the second category referred to.

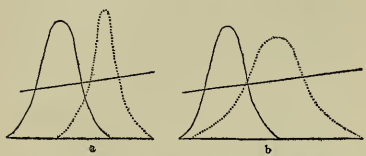

Fig. 17. The straight solid line is the survival rate; the dotted line, the polygon of the individuals as modified. To illustrate action of coincident selection in decreasing and increasing variation.

The study of the analyses which have been presented brings out some facts as to correlation of characters which should be mentioned here. It is often assumed that every character that is selected has a direct survival value. Some authors have recognized that a characteristic may be carried along by correlation with some related characteristic which has survival value. In these cases, the correlated characteristics are generally thought to be two distinct structures, for the correlation of which a reason is evident. It will be noticed, however, that in the case of the sparrow catastrophe, the several dimensions, aside from the length, are all selected in the positive direction and that they are all dimensions of head or limbs except the length and one body measurement, which is taken in the cephalo-caudal direction. The one characteristic not of this sort, weight, had an indifferent survival value. If we try to reason out particular advantages in each of these character changes, we are hard pressed.

Is it not probable that they are all correlated with a physiological characteristic or two, which has its external manifestation in a general increase of peripheral parts and slenderness? This is not fantastic, for we have something analogous in human pathology. The disease of acromegaly, caused by some condition of the pituitary body, produces a great increase in height and in the size of the hands and the feet. The survival value of length of antennæ in moth pupæ, the number of rostral spines of a shrimp, affected by changed salinity, are inexplicable on the basis of direct adaptation. We are driven to resort to correlation with internal features. But the frequency with which this resort to correlation is necessary in the discussion of the experiments on survival values seems significant. Even in case of the frontal breadth of the crab, where a definite value has been postulated, namely, that the narrowness of slit which permits water to reach the gills may be of importance in excluding mud, we are still dealing with a correlated character.

The multiplicity of structure that we find in animals, particularly in sculpture and markings, is simply bewildering, if we consider them all as adaptations. But with an appreciation of the great rôle played by correlation in natural selection, we should expect just such a wonderful maze of characteristics. Just as our modern insistence on the importance of the variations that offer themselves reduces the creative rôle of natural selection, so does it become further reduced by emphasis on the importance of correlation, rather than the direct usefulness of the characteristic in question.

Of course, it is unfortunate to be obliged to find that so much of importance in evolution is not to be found in the more easily understood and investigated work of direct selection. It seems like a step backward, to be obliged to conclude that not only do we know less than we thought we did, but to also have important avenues of investigation either closed or made very difficult. It bewilders us to realize that the most fundamental factors of evolution lie in the abstruse, deep-lying problems of the origin of variations and their correlations. A gleam of promise lies in the recent induction of variations by Tower and MacDougal. Epochal as these results are, they may be said to be more the evoking of variations than the making of them. The greatest promise for light on the origin of correlation probably lies in the study of internal secretions and in the transplantation of tissues and organs.

This position in reference to correlation has its significance for the guidance of further experiments on survival values. I do not believe it is necessary to pick out obviously adapted characters for selection experiments. In proper analysis with large numbers, most causes of death will probably show discrimination with most characteristics. We may, therefore, expect to get appreciable results in aquatic animals by altering salinity or carbonic dioxide content or muddiness, and in terrestrial animals, by altering temperature, humidity, etc. On the other hand, there should be care in selecting the species with reference to the following conditions:

1. The animal should be readily obtainable in great numbers.

2. The sexes should be readily distinguishable.

3. The adverse condition should be capable of being applied evenly to any desired degree with the least possible alteration of other conditions.

4. The species should have an allied variety or species living in the new environment, which differs from it in the characteristic chosen.

5. The characteristic should be one easily measured or counted and show a good range of variation. Measurements should be ordinarily expressed in percentage of length.

6. The characteristic should not change with age, or at least not within some adult size unit to be used.

7. A further advantage lies with a species capable of being successfully bred. It may become desirable to get light upon some point by this method.

Of course natural selection is determined not by the death rate at any one catastrophe, but by the end result of the various vicissitudes that all the individuals of a species pass through from the laying of the egg to the completion of reproduction. It is therefore dangerous to conclude that the natural selection seen in any of these experiments, which all express the result of a part only of the life of the individuals, was actually producing evolution in these species. Of course, diagrams such as these must not be expected to give the entire evolutionary status of a group of individuals. We may have such a condition as shown in Fig. 17 and still have the species stationary, for the advantage in one direction may be much reduced or wholly lost by selection in the opposite direction in some other catastrophe or critical period of life. Thus, long antennæ were favored in the pupæ of *Philosamia cynthia*. It is quite possible that short antennæ might be favored in the imago, for conditions are so dissimilar. Slenderness was an advantage to sparrows in a blizzard, but compactness might be in dodgeing hawks. The lethal selection may also be counteracted by sexual or fecundal selection, modification of the germ plasm, or orthogenesis. For a time any one of these influences may even force the species in the opposite direction to that in which lethal selection is impelling it.

The relation to orthogenesis is especially interesting. Orthogenesis is a progressive variation or biased heredity in a given direction in successive generations. It is not a constant process, but one which is active in a certain characteristic in a particular species for a limited time, while most other characteristics are untouched by it. Let us call one of these lines of orthogenetic activity an "orthogenetic run" after the analogy of the "run" on a special line of merchandise which merchants occasionally experience. In such an orthogenetic run the individual steps are often not affected by selection up to a certain point, or only to so slight a degree as to be relatively negligible. But a "run" may eventually reach the threshold of a decisive selective value. Natural selection will then stop the course of the run. The "run" may be eradicated from the species, or when it is too persistent to be eradicated, then the species will be exterminated, as I imagine has taken place in the Irish elk and in the excessively spiny species with which many extinct mollusc genera have culminated.

But the result of such continued checking of inimical runs and the tolerance of other neutral or beneficial runs is to determine to some degree the kinds of "runs" that will arise in the future. Thus "runs" dealing with distribution of hair and hair modifications in great variety have been tolerated or encouraged, so that runs of this kind became commoner. On the other hand, runs affecting the chemical constitution of the red blood corpuscle once it had reached the vertebrate standard have been so promptly checked that variation in this characteristic has been checked and a high degree of conservatism resulted.

The analysis of the experiments given has a further value in its bearing on the question of the possible selective value of minute variations. Indisputably there has been too general a faith in widespread selective values in the past. At present, however, we can see evidences of an unjustifiably extreme reaction. In the consideration of selective values, critics have been wont to compare two adjacent classes of the frequency polygon and to descant on the improbability of a selective value. A safer viewpoint is to consider the chances of two classes not immediately adjacent. If a selective value is found between some two classes, we may be fairly sure that the selective value will not end abruptly, but become less step by step in passing from one class to the other. It is absurd to expect a high survival rate in one class and a low one in the next. In almost all cases we must expect the survival rate to gradually increase or diminish from class to class. This is the verdict of the experiments. It is idle to talk about the impossibility of selective value of minute differences, when it is possible to measure and analyze them.

The object of this paper has been to develop the method of analysis of natural selection by the construction of survival curves, in order, first, to extract more meaning from the experiments already performed, but second, and especially to encourage further selection experiments by making it possible to obtain more significance from them. Its publication has been delayed four years that the author might add some applications of the method. Occupation upon another line of research makes its publication necessary now without such results in the hope that they will be supplied by others.

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SPECIAL ARTICLES

BOTANICAL EVIDENCE OF THE AGE OF CERTAIN OX-BOW LAKES

In the southeasternmost county of Arkansas, near the Mississippi River, there is a crescent-shaped ox-bow lake about 15 miles long, of a type frequent in the flood-plains of large sluggish rivers, known as Lake Chicot. Lake Village, the county-seat of Chicot County, is located on the side farthest from the river, and the railroad from that point to Luna Landing on the Mississippi skirts its northern bank for a few miles. At present the shores of this lake are mostly pastured, but at the water's edge on both sides, where it is visible from the railroad at least, it is bordered by a thin fringe of small cypress trees (*Taxodium distichum*).

Observations on this tree in all the southeastern states and in fourteen different years have led me to believe that it is rarely or never found on the banks of rivers or other bodies of water which have an average seasonal fluctuation of more than ten or twelve feet. Its trunk usually emerges from the ground just about low-water mark, and its enlarged base and "knees" are generally believed to reach up approximately to the average level of high water;[1] the figures just mentioned being about the maximum height recorded for these excrescences. Now the Mississippi River in the latitude of Lake Chicot has a seasonal fluctuation of about forty feet, and the cypress is absent from its immediate banks, though visible from the river in some places where it grows in nearby sloughs not directly connected with the main channel.

Presumably, therefore, when the waters of the Mississippi flowed through what is now Lake Chicot the cypresses which fringe the lake to-day did not exist. When the lake was cut off from the river, in the manner described in all treatises on potamology, its seasonal fluctuations were of course at once greatly reduced, and conditions then became suitable for the growth of the cypress on its banks. Consequently if one could determine the age of the oldest of these trees, by counting the annual rings or otherwise, that would give a minimum estimate of the age of the lake. As I have seen this lake only from the train, I have no data about the annual rings of its cypresses, but there is some evidence of another sort that they are comparatively young for that species.

Young cypress trees, of either species, are spindle-shaped in outline, much like the typical conventional conifers of the cooler parts of the northern hemisphere, while mature individuals are always more or less flat-topped, a character by which they can often be distinguished from other trees at a distance of several miles.[2] At just what age *Taxodium distichum* reaches its maximum height and begins to develop a flat top has not been determined, but very likely it is between 100 and 300 years.[3] The cypresses of Lake Chicot are mainly spindle-shaped, and perhaps date back only to the eighteenth century.

This supposition could easily be tested by a visit to the place in question with suitable tools. At the same time the cypresses bordering other ox-bow lakes along the Mississippi, especially those lakes whose age is a matter of historical record, should be examined from the same point of view. Additional evidence might be gathered from other swamp trees, especially the tupelo gum, *Nyssa uniflora,* which is common in sloughs and rare or absent on river-banks, bearing about the same relation to seasonal fluctuations of water that *Taxodium distichum* does. But the cypress is best for this purpose, on account of its longevity.

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[1] See *Bull. Torrey Bot. Club,* 32: p. 108, 1905.

[2] Hilgard ("Soils," 507–508, 1906), Cowles ("Ecology," 734, 1911), and some other writers have noted that the cypress when growing in uplands, such as parks, is spindle-shaped (see illustration in *Rep. Mo. Bot. Gard.*, 15: pl. 16, 1904), and have tried to correlate shape with habitat. C. S. Chapman (U. S. Bureau of Forestry, Bull. 56: 41–42, 1906) ascribes the flat top of cypress in Berkeley County, South Carolina, to the disease known as "peckiness," while Cowles, in the work cited, considers the flat-topped trees dwarfed on account of "the imperfect absorption which is characteristic of swamps." But age alone would seem to be a sufficient explanation of the difference in shape, since there is no doubt that all the younger trees, whether in their native swamps or in parks, are spindle-shaped, and the largest individuals known are flat-topped.

[3] The species has been known to civilized man only about 300 years, and presumably none of the existing cultivated specimens are old enough yet to have lost their juvenile form.

ON COMPARING AMMONIFYING COEFFICIENTS OF DIFFERENT SOILS

In a recent publication[1] Professor W. G. Sackett gives some interesting results of a study of the ammonifying powers of some Colorado soils, among them some of the now well known "niter soils" and some of the normal soils of the state. In concluding the discussion the author attempts a comparison of the ammonifying powers of soils from different states with his own, in which he quotes data on the subject obtained by J. G. Lipman as regards New Jersey soils, F. L. Stevens and coworkers as regards North Carolina soils and the writer as regards a California soil. From the comparison Sackett concludes that the niter soils of Colorado show a much higher ammonifying efficiency than soils from other states and than the normal soils of Colorado.

Despite the fact that Professor Sackett makes some qualifying statements in discussing the comparisons, he does not seem to attach importance enough to some factors of which he appears to be fully cognizant, and gives no consideration to other very important factors. The writer of this note fails to appreciate the value of a comparison of the ammonifying powers of various soils as obtained by different investigators whose methods vary as much as ours do to-day. Not only is it true, as Professor Sackett points out, that the time of incubation may be responsible for *some* of the differences found between his normal sandy loam and the one with which I worked, but differences of great magnitude can easily be obtained in changing the length of the incubation period, as J. G. Lipman has repeatedly shown in his long series of investigations on ammonification at the New Jersey Experiment Station. Moreover, the writer has found different brands of dried blood to vary so much in composition, both physically and chemically, that no fair comparison can be made without employing not only the same period of incubation and the same temperature for all soils but also the same kind of dried blood.

Other important factors also militate against a useful comparison of the ammonifying powers of different soils as obtained in laboratories varying widely in their methods of studying such problems. For example, Professor Sackett sterilizes his soils with mercuric chloride and then rinses them with sterile distilled water prior to inoculation with a *soil infusion*. In my laboratory soils are used directly for cultures without the use of a soil infusion. Others may use either procedure or both. I fail to see how one can safely compare the flora of a soil in its natural condition with a partial flora introduced through a soil infusion. The act of sterilizing a soil has been amply shown to be favorable to nitrogen transformation, but if in addition to that the soil is rinsed with water, it is obvious that the culture medium may become an entirely different one and yield a different ammonification coefficient from the same soil unsterilized or unrinsed. A soil infusion equivalent to 5 grams of soil may give a very far different bacterial development, possessed of very far different powers from the whole flora of 100 grams of soil. It must also be added here that the comparison of only a few soils can not be invested with much importance even if the soils are described by similar names. It is of course obvious that sandy loams may embrace soils of very widely differing natures and that no just comparison can be made between a sandy loam so called in one district with a sandy loam so called in another district.

As to the ammonification coefficients of niter soils as compared with those of normal soils the writer begs to add that he has on several occasions noted a high ammonifying power in soils of this state containing abnormal amounts of nitrate and has attributed that not only to a partial denitrification of the nitrate but also to an enormously increased development of putrefactive organisms in these soils which always produced large amounts of ammonia. I have also noted the same thing on two niter soils derived from the vicinity of Grand Junction, Colorado.

Chas. B. Lipman
Laboratory of Soil Chemistry
and Bacteriology,
University of California

[1] Bull. No. 184, Colorado Experiment Station, Part 1, June, 1912.

SCIENCE

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THE LANE MEDICAL LIBRARY OF STANFORD UNIVERSITY [1]

We have met to-day to mark a milestone in the history of Stanford University, on the one hand, and in the history of medical education, on the other. It is a milestone that we mark, not an epoch, for epoch-making events do not often appear more than once in a lifetime. But a milestone marks progress, even though after it is set up all shall go on as before.

Stanford University is now twenty-one years old. Its days were opened on a hopeful morning of October in California where all days are hopeful, just twenty-one years ago. It has come of age. It is old enough to be doing the work of a grown university.

And there is no work of the university more worthy or more needed than medical instruction and medical research, the training of men who shall help their fellows in all their bodily ills, on the basis of the best and fullest knowledge, while themselves adding day by day to the world's stock of wisdom. In these days medical research stands on the firing line of the advance of science. There is no branch of knowledge which is moving more rapidly and there is none which contributes equally to the aggregate of human welfare.

We dedicate to-day the home of the Lane Memorial Library of Stanford University to medical practise and medical research. It is the gift of the will of Mrs. Levi Cooper Lane. It begins its existence with a handsome building, adequate for its needs for years to come. When it must be extended we hope that the grateful people of San

[1] Address by David Starr Jordan at the dedication, November 3, 1912.

Francisco will be here to see that all its needs are met.

It has already on this initial day a library of nearly 40,000 volumes, all relating to medical practise and medical research, a good number of books, as you will see when you compare it with other libraries devoted elsewhere to the same subject.

The importance to San Francisco of such a collection of medical books kept up-to-date by a steady inflow of the best journals and monographs is obvious. The library is the natural center for creative effort and hence for all research, since there is no loss of energy so needless as is the doing again that which has been well done before. All new work must be based upon knowledge that has gone before. The breath of life of all research is the joy of seeking for the unknown. Chance discoveries of great moment in medicine are no longer to be made at random. Piece by piece must new truths be found and correlated. Each investigator must rest his work upon that of others. He must stand on the shoulders of the past if he is to look into the future. To know what has gone before is only possible where accumulated records are at hand. In the library which we dedicate to-day is massed the product of thousands of minds, some great and far-seeing, some small but earnest, but all seeking after truth. The great function of such a library as this is to accumulate and classify and make ready of access the knowledge that the world has already gained and to keep abreast with the steady current of advancing medical science, choosing from it all that seems likely to be worth while. Such a function is a difficult and responsible one and one that will be performed in fuller and fuller measure by this library as it meets more and more with the support of the great state in which it is located. Indeed its interest should extend far beyond the confines of any one city or state, for no such collection of medical books is to be found elsewhere on this continent west of the Mississippi nor along the shores of our great ocean so soon to be expanded by the Panama Canal; itself a product of human skill that has been made possible by the advance of the science of medicine.

The Stanford Medical Department with its medical building, including Lane Hall, its Lane Hospital and its Lane Library, are, as you have already heard from my colleague, Dr. Rixford, the gift of the eminent surgeon, Levi Cooper Lane and of the faculty of Cooper Medical College. Dr. Lane first established the Cooper Medical College, named by him for his uncle Dr. Elias Cooper. But as the future of medical instruction must lie with the universities, and as sound medical instruction must rest on university courses in physiology, chemistry, biology and physics, Dr. Lane made arrangements whereby the board of directors of Cooper Medical College were able to deed this property to Stanford University on the sole condition that the university should use the gift of money and buildings for medical instruction. The corporation of the Cooper Medical College has dissolved itself, patriotically turning over its good-will and all its properties, hopes and achievements to the larger institution, and Stanford University has loyally accepted the trust and is doing the best work it knows how to do in the line of the acceptance of these pledges.

The function of the privately endowed university, as the authorities of Stanford understand it, is to set standards in education and to uphold these standards. It must set standards in service to society as well as within its own classrooms.

In whatever way a school of medicine can help the people it is its duty to render aid. The hospital is the laboratory of clinical medicine. This has become an axiom in modern medical instruction. But a further duty is incumbent on the university hospital of to-day. It should be so conducted and controlled as to serve as a model for all that is essential and worthy in the institutional care of the sick. Only in such a hospital with its numerous internes and assistants and its trained staff can satisfactory control be made of new methods of treatment and such treatments standardized for use of others. The elevation of nursing standards, the thoroughness of case study and care that inevitably follow the well-trained student into the hospital and ward are the great boon of a university hospital. All this involves an effort at the best in research, in training, and in character building.

The funds of a private institution are limited. It can call on no legislature for help if it has undertaken more than it can carry out. It must be sufficient unto itself. This means limitation. It can never cover the whole range of knowledge, nor the whole range of practical achievement. It can not make its campus coextensive with the state. It can not provide for multitudes of students, dependent on fees, unless it makes these fees so high as to be prohibitive to self-helping men and women. To this class belongs the vast majority of the students we in the west find worth while.

But the private institution has its own advantages. It has freedom of development. It is dependent on no outside influence for its direction. It can undertake what it deems best worth doing. It can insist on the highest standards. It is above all temptation to grant university titles or degrees to the products of four years of frivolity, dissipation and sham. Above all, it has the privilege as well as the duty of making its professional courses of such a character that it can be sure that every graduate is really a university man. It is not claimed that the private university has any monopoly of high standards or of efficient practise. It claims only that no other type of institution has the right to loftier ideals. In proportion as it is true to its opportunity its aims should be the highest within its range of possibilities.

No institution can do better than its best. If it falls short of this, it has no adequate reason for being. And Stanford University means to justify herself. She is pledged to justify herself in the direction of medical instruction. And after all, in the multiplicity of medical schools instruction in medicine is nowhere overdone. The profession of physician is overcrowded because its men are undertrained. It is a very true expression that there is always "room at the top." In medicine as elsewhere in life the crowd is around the bottom of the ladder.

A young medical student in New York, it is said, committed suicide not long ago, leaving behind him his word: "I die because there is room for no more doctors." Room for no more doctors just now when in the history of the world it is most worth while to be a doctor! Now when the progress of the sciences and arts which deal with sickness and health have given the intelligent and honest doctor a power no one else has ever had before over the forces of sin and death!

Another medical student was asked how he dared to return to take so much time to prepare for a profession already so overcrowded. "I propose to practise medicine," he said, "those in the crowd must look out for themselves."

Frederick Denison Maurice once said: "Make your system of education such that a great man may be formed by it, and there will be manhood in your little men of which you do not dream."

And to such a system of instruction in medicine, a system which may form great men if great men come within its reach, this beautiful library is dedicated. And all resources of Stanford University stand pledged to make this purpose good.

I said just now that medical research is now on the firing line of the advance of science. It has left behind it as outworn garments all medical theories, and all schools of medicine. The medical advance is the work of no school, the offspring of no preconceived theory.

One of my early students, on graduating in medicine, was asked to what school he belonged. His answer was "I have nothing to do with schools. I am trying to practise medicine." Just as soon as men seriously try to practise medicine, schools of medicine cease to exist. These belong to the metaphysics of the dark ages, when men, in default of science, tried to practise philosophy.

At the most or at the best, a school indicates merely a preference for one mode of therapeutics over another, or over all others, a matter of very minor importance as compared with knowing the nature of the ailment in question and of causes which brought it about. Accuracy of scientific knowledge is fatal to the prearranged theory of treatment of disease, the basis of any school of theoretical medicine. Accuracy of knowledge goes beyond symptoms or surface indications. It is with symptoms and symptoms only, in default of knowledge, that varying schools of medical therapeutics become possible. When we know the actual conditions which give rise to symptoms, all methods must rest on these conditions.

All art is based on science. Science is human experience tested and set in order. Art is knowledge in action. An art which is not based on knowledge becomes a mystery or a trade. The practise of medicine through the ages has been one or the other or both. It is a trade when the physician apprentice follows his master about, learns his ways, his prescriptions and his professional dignity. It is a mystery when practise is based on some theory of therapeutics which goes outside of human experience for its justification.

Science is alike to all men who have grasped its data and its conclusions. Art will vary with the personality of the individuals who practise it. Sound medicine must rest on science. Whoever treats the ills of the human body successfully must know this body in health and in disease. He must know the range of its disorders, its abuses, its dislocations and its parasites. Those who try to heal without knowledge of the actual conditions with which they deal are of necessity impostors.

The limit of "medical freedom" is a very plain and natural one. Let the patient take whatever kind of treatment he may wish, but let no treatment be administered by persons who have no knowledge of the fundamental facts of medical science. If the requirement of technical knowledge is fatal to any school of therapeutics, it is time that that particular form of robbery should be done away with. Taking chances with the lives of others for the money there is in it is not a profession to be encouraged.

The basis of the varying schools of medicine lies not in science, but in the varying theories of symptoms. In the old days, when microorganisms were unknown, where physiology was elemental and pharmacology itself a form of metaphysics, it is not strange that symptoms engrossed the attention of the practitioner and that there grew up widely differing theories in regard to their treatment.

It was natural in these days, that men should face symptoms with remedies calculated to remove or obscure them. This method, contemptuously designated as allopathy, "unlike treatment," as the drug and symptom were unlike, had in it the germ of better things, because it gave play for experiment and was not bound hand and foot by any predetermined notion.

It was a step forward from the idea of the dark ages, that each disease had some definite predestined remedy, that for each ailment, that is, a special group of symptoms, there was somewhere, somehow, some cure mysteriously provided in nature if we could only find it out.

As the plant world lies all about us, as most plants secrete or produce something with a definite odor or taste, balms, resins, aromatic oils, bitter alkaloids, strange substances useless for any purpose unless it be that of medication, it was natural that men should turn their attention to these substances. Some of these products or simples showed strange effectivenesses. Others did no harm and were therefore suspected of doing good. Quinine was thought to cure malaria by setting up a feverish condition like that arising from malaria itself. Digitalis controlled the action of the heart. Mandrake, senna, rhubarb kept the intestines open. The pink (*Spigelia*) was death to worms. Yerba buena, yerba santa, sage tea, catnip tea, tansy tea, sassafras tea, as well as tar, molasses and sulphur, were "good for the blood," especially in the spring, and the tonic effect of almost any bitter bark dissolved in alcohol was highly appreciated.

Out of this notion that a specific disease had a specific cure, naturally arose the form of quackery involved in the patent medicine. Its practical value lay in the elimination of the doctor, or rather in postponing his arrival until near the end. It is very simple, by reading an advertisement in any easy-going newspaper, or by the perusal of an almanac, to pick out your own disease from the list of symptoms graphically set forth. Almost every one has felt headaches, twinges, blurrings, ringings, smartings, achings, givings and misgivings and these will indicate the necessary drug. If this drug be essentially whisky and water made sweet or bitter by some easy stain, or if some more virulent or effective poison is used, there is likely to be enough of apparent satisfaction or of change in symptoms to justify a written testimonial and another bottle of the drug.

Or if the basal constituent of the medicine be merely water, the effect of hope with the lack of visible harm is likely to lead to the same results. In either case, the self-medication is likely to produce no effect or an effect worse than nothing.

While much that is now sold in the drug stores represents merely a harmless or sometimes useful physician's prescription, the aggregate result of the patent medicine is the building up of gigantic systems of robbery, on the one hand, and a corresponding damage to public health, on the other.

The way out of the patent medicine domination lies in the better training of physicians, on the one hand, and the enlightenment of public opinion, on the other. No more effective agency exists for the forming of public opinion than an aggressive administration of the Bureau at Washington which deals with pure food and pure drugs. No single agency in this direction has counted for so much as the personal work of one man, who has spent his life in fighting frauds and poisons. But we must have a hundred Wileys in the public service where we now haven't one.

Among the host of specifics men naturally sought for some guiding rule, some informing spirit that would tell them beforehand and once for all how to match these diseases with the predestined healing agent.

Sometimes this was found in the looks of the plant. Its flowers or leaves or roots somehow simulated the disease it was found to cure. Thus the figwort was denominated *Scrophularia,* apparently for its scrofulous appearance. The liver-shaped leaves of *Hepatica,* the liverwort, showed clearly what was expected of it. And in the ignorance of what was really the matter and of what really happened after a remedy was absorbed, there were as many successes as failures, and the dark mysteries of the profession prevented any following up of either.

A more scientific application of the method of resemblances lay in the study of the effects produced by a drug in relation to the symptoms of the malady it was to cure. Like symptoms, like effects. Like cures like. If your patient is troubled with colic, give him a colic-producing drug. If with eczema give him something to make the skin smart. The same principle would hold for all diseases.

But with this went the saving clause of homœopathy or like treatment. Don't give too much, and give good nursing. As time, patience and good nursing are the best of drugs, this method has had a large vogue as well as a large effectiveness. If it is based on a sound study of the human body, its defects, its slips and its parasites, this method must merge into the real practise of medicine.

For knowing the distemper, its causes and its range, the method of treatment is a minor matter. The idea that a disease has a definite drug as its remedy, whether in large quantities or small, is a relic of the middle ages. Drugs do not heal anything. Some are palliative, resting in the category of vaseline, cold cream or talcum powder, some kill parasites directly as quinine kills the animal organisms known as malaria. Sulphur is death to the itch, the visible cause of the distemper once thought almost incurable, and known as the "gall struck inwards." Others do evil as stimulants or counter-irritants, that good may come, helping on the one hand through the incidental damage on the other.

But the metaphysical relation of drug to symptom has no existence and has passed out of medical practise never to return.

With doubts of the efficiency of drugs as remedies came theories of therapeutics by which all drugs were discarded. Orthopathy in its day rejected them all, relying on the well-known disposition of nature to heal her wounds whenever she is let alone. Hydropathy set people to sweating under close envelopes of wet sheets, often, it is true, to their great advantage. I can remember when the wet sheet packing and the over soul were the test and signal of a progressive nature, much as to-day are the referendum and recall.

Mind-healing in various forms has always found its place. It is a notorious fact that when the symptoms of any disease are graphically set forth, the average reader finds most of these symptoms in himself. It is only a step to the conclusion that these symptoms are the cause of the disease. If you can create the impression that the symptoms do not exist you take away the disease. For disease and symptoms are alike the product of morbidity of mind. To have faith is to cure this morbidity. One of the leaders in this form of therapeutics says:

> Sin, Sorrow and Sickness are all three illusions of the Sinful Soul. . . . They are but troubled

dreams of the darkened soul. . . . In afflictions of disease and dread and death one must say "This is a dream." Then it becomes a dream and we rise above it into an atmosphere of perfect serenity. . . . We need not deal with the body, for the body does not exist. It is dull, heavy and aching because it is the dead Residuum of Dream. When we forget it, it is no longer there. Treat a belief in sickness as you would sin, with sudden dismissal.

It is undoubtedly true that a serene spirit is a valuable agency in the recovery from disease. It is likewise true that suggestion has a mighty potency when it is rightly applied. It is a legitimate and recognized branch of therapeutics, which may be destined to have a wide application in the future treatment of disorders of the nervous system.

But it is likewise true that suggestion heals no broken bones, a spirit unperturbed gives no safeguard against poisoned mosquitoes and the power of the will and the imagination is potent chiefly against disorders of the imagination and the will.

The first and most important thing in any treatment is to find out what is the matter and then, if may be, to remove the cause from which the symptoms flow. No system of philosophy, no cult of religion, gives us any help as to matters of fact. It does not strengthen our knowledge of the demands of the body to deny the body's existence. The whole fabric of modern science, the whole fabric of modern civilization, is based on the conception of the reality of external things. The sanity of life is conditioned on our belief in realities, the mental state produced by contact with external things as distinct from illusions, those mental states arising from conditions within ourselves. This distinction is the foundation of safety in life. Our body through its nervous system is cognizant of realities. The defects in this nervous system may cloud our view with illusions. The art of sound living is to discriminate between the two sets of impressions. To confuse reality and illusion is to confuse life and death. To show that perception and reason may sometimes be deceived is not to add reality to the figments of imagination. It does not advance science to doubt the things we know to be true in order to give proof to propositions we know to be false.

We may be therefore certain that progressive medicine will still believe in the reality of the human body and the rational veracity of the world of sense.

We may be sure that medical science does not grow in accordance with the theories of any school of medicine or of metaphysics. It is advanced by the study of things as they are, by the use of tools of precision on definite problems, by the microscope and scalpel, the test tube and reagent, by the culture of germs and the discovery of germ-killers. It grows by probing the actual causes of bodily disturbances and the actual removal of such causes.

It grows as all sciences have grown by the method of induction, by putting two and two together and verifying the apparent existence of four as a resultant.

And in the future of medicine, the mere removal of disease must play more and more a subordinate part. Most disease can be prevented. Above all therapeutics stands sanitation. It is possible to remove causes of disease long before any disease begins. It is possible to heal our patients before they are ever sick. Our knowledge in many fields is now adequate for this result. No one can be attacked by an infectious disease unless we have somehow or other permitted the infection.

In modern war, it now costs on the average about $15,000 to kill a man. In the late Boer War, this expense ran up to nearly $40,000. It is cheaper to save men. It is cheaper to stop killing. In our own country, in the time of peace, when nothing but peace is possible among civilized nations we spend nearly a million dollars a day on matters concerned with past or future wars; $850,000 a day, on future wars alone, that we may not be caught napping when the day of the impossible shall arrive.

A wiser and more civilized nation would give some part of this sum to the prevention or stamping out of the worst of infectious diseases. For if we are napping these are sure to come. The danger of the red plague, present everywhere, is infinitely greater than that of war with any part of Europe or of Asia. The terrible infliction of the unknown parasite which shows itself as infantile paralysis awaits the strong arm of the people to set it aside entirely. No infectious disease would long exist if we made adequate quarantine provision. Its germs, animal or plant, must be carried from man to man, or from animal to man, else the race of parasites would die out. Now that we know what our enemies are, it is possible for us to fight them. This I said in a review of Tyndall's work which I printed thirty-five years ago. Now that we know what our enemies are and now that we know that they can be fought successfully only by national and international cooperation, it is our duty thus to fight them. It shows a lack of national manliness to continue to bear these ills when a little energy with the knowledge we have is adequate to throw them all off.

I am still a young man, I am sure of that. As I said once before, when I hear the students speak of Old Jordan, I know that they mean the river of Palestine, or perchance in these days a forbidden brand of alcoholics. They do not mean me.

It is not so many years since I received the degree of doctor of medicine, and I hasten to say that I have never practised medicine and never intended to, so that my failures in knowledge have never harmed any one, nor brought me a dollar of unearned increment.

But at that time in 1875, the words bacterium, bacillus, microbe were all unknown, all slumbering together in the Greek Lexicon. This lexicon gave no suspicion that *βακτερίον* and *λογός* would come together to form a science, and that the one science most vitally related to human life. The world of science and therefore the province of medicine knew nothing of invisible one-celled animals and plants, bacteria and protozoa, which flourish and run their courses in the life blood of living animals. The source of infection in disease was then called a virus and the growth of a virus was an extension of death. Carlyle had said that a fallen leaf must still have life in it else how could it rot. But neither the poet nor the prophet realized that this life which tore the fallen leaf to pieces was the life of a multifarious group of one-celled vegetation whose function it is to return all organic matter not still active back to the universe in its constituent elements. In those days malaria was an evil spirit or miasma, the product of bad air or may be of bad water. All plagues were of the same sort. No one suspected the mosquito, the fly, the flea, the louse, the bedbug or the woodtick of harboring any vices worse than those which their bite or their presence suggests.

There was no science of infectious diseases and therefore no art in curing or preventing them. The most that could be done was to let them run their course, allaying as may be some of their most annoying symptoms.

Antiseptics were only guesswork. We had not heard of carbolic acid, or barely heard of it, and the coal-tar products with their varied possibilities of usefulness and mischief still lay in the fossil beds of the earth. Surgery was a matter of luck, a gamble, as the phrase is, still conducted, as has been said, "along the lines laid down by the early Egyptians." There had been no Lister to show the reason for clean knives, clean hands and clean air, and the battlefields of those days were a wild riot of the germs of gangrene and blood poisoning.

As surgery did not exist, we knew nothing of preventive surgery or the surgery of pathology.

As medicine dealt with symptoms, we knew nothing of pharmacology. These were the days before Michael Foster and physiology was still merely a series of deductions from the facts of elementary anatomy. The nature and structure of the body cell was very scantily known. Without knowing the germ cell, the physical basis of heredity, the science of heredity was unknown, and without accurate knowledge of heredity, the science of eugenics can have no existence or meaning.

At the present time, the facts and laws of pathology are to the trained physician as essential as the alphabet or the multiplication table to the rest of the world. But we poor practical doctors of our day had to get along without it. Science had not reached so far, and we had to be practical men because, perforce, we could not be scientific. Dr. Charles Sedgwick Minot has well pointed out the distinction. He says:

> The only important difference between the practical doctor and the scientific doctor is that the patients of the practical doctor are more likely to die.

In healing men, as in other lines of industry, the first requisite is to know how. To know how is the essence of science.

The next stage of the scientific doctor is not merely to cure his patients, but to help conduct the affairs of the community so that men and women will no longer come to him as patients to be cured.

Half the disease of the world comes from the infection of the crowd. Nine tenths of the infection of the crowd could be spared if the knowledge we have could work itself out in governmental action.

The governments of the world are about the poorest tools we know of for the achievement of good deeds. They are controlled by tradition, by prejudice, by the noise of the drum and fife. They are ruled by influence of caste and privilege. They are bigoted and wasteful and when they deal with the individual life they are likely to be careless and unjust.

But in dealing with the great plagues of the world, the black, the yellow, the red and all the poisonous array of health-breaking parasites, the government is the only tool we have. The individual is helpless, the community is all. The acts of the community can not rise much above its knowledge. All effective government is by public opinion. The people must learn the facts of pathology and of sanitation. There is no school of medicine which can honorably come between them and the truth.

And that the Lane Library of Stanford University, the Medical Department of Stanford University and the university itself, may do their part in the great work of bringing health to the people, and that they may cooperate with the sister schools and with all other good agencies to good ends, is the motive behind the functions of to-day.

ANTRITTSVORLESUNG[1]

Eure Kaiserliche und Königliche Majestäten! Hochansehnliche Versammlung!

Der erhabene Wunsch Eurer Majestät,

[1] Am 31. Oktober in der neuen Aula der Universität zu Berlin gehalten.

einen regeren Verkehr zwischen Deutschland und Amerika zustande zu bringen, hat zu dem Professoren-Austausch geführt, der sich als ein wirksames Mittel zur Beförderung der Wissenschaft und zur Annäherung der beiden Völker erwiesen hat. Wie er geschätzt wird, können wir daran erkennen, dass der Austausch der Professoren sich ausdehnt und schon mehrere Länder in engere Beziehungen zueinander bringt. Wir erkennen dankbar an, dass der geniale Gedanke Eurer Majestät schon eine welthistorische Bedeutung gewonnen hat.

Seiner Exzellenz dem Herrn Kultusminister und Seiner Magnifizenz dem Herrn Rektor der Friedrich-Wilhelms-Universität überbringe ich als der diesjährige Vertreter von Harvard die Grüsse der ältesten Universität der Vereinigten Staaten an die grösste und grossartigste Universität der Welt—möge sie gedeihen und ihre hervorragende Bedeutung durch alle Zukunft behalten. Die Kultur eines Landes lässt sich am besten an seinen Universitäten ermessen. Die weitsehenden Ratgeber, die zur Begründung der Königlichen Friedrich-Wilhelms-Universität beitrugen, erkannten schon die Universität als die Hauptquelle der Kraft und der Bildung des Volkes.

Dem tieferen Sinne des von Allerhöchster Seite ausgesprochenen Wunsches zugunsten des Professoren-Austausches hoffe ich dadurch zu entsprechen, dass ich mich als den Repräsentanten der amerikanischen Wissenschaft betrachte, dessen Hauptpflicht es ist, Sie mit unserer wissenschaftlichen Tätigkeit besser vertraut zu machen, und zwar nicht, weil die amerikanischen wissenschaftlichen Arbeiten an sich besser seien, sondern, weil sie verschieden sind und infolge der Schwierigkeiten des Verkehrs bei Ihnen bis jetzt nicht so bekannt geworden sind, wie sie es ihrem inhaltlichen Werte nach sicherlich verdienen. Aus diesen Gründen habe ich mich entschlossen, dem mir von hiesigen Kollegen erteilten Rate Folge zu leisten, indem ich meine Hauptvorlesungen der Schilderung der von meinen amerikanischen Fachgenossen in den letzten Jahren gemachten Entdeckungen widmen will. Die betreffenden Entdeckungen aber sind viel zu zahlreich, als dass ich alle werde berücksichtigen können.

Wir werden also bei der erwähnten Hauptvorlesung mit den Ergebnissen der amerikanischen Forschung im Gebiete der Anatomie und Entwicklungsgeschichte zu tun haben. Die in Betracht kommenden Entdeckungen sind zum Teil von fundamentaler Bedeutung.

Ein Beispiel: Wichtig ist der Begriff der Cytomorphose, das Grundgesetz der Umwandlung der Zellen. Dieser Begriff ist in Amerika schon geläufig. Es gibt auch mehrere Untersuchungsfelder, die fast ausschliesslich von amerikanischen Forschern kultiviert worden sind. Hier sind folgende Gebiete zu erwähnen: die Entstehung des Geschlechtes, eine uralte Frage, deren Lösung uns jetzt endlich möglich erscheint;—die Entwicklung des lymphatischen Systems, womit das Grundproblem der Entstehung der organischen Struktur überhaupt eng verbunden ist;—ferner: die Beziehungen der Nerven zum Gehirn, die zu bestimmen es, unseren Neurologen durch mühevolle Analysen gelungen ist, wodurch eine unerwartete Vertiefung unserer Erkenntnis des Hirnbaues erreicht wurde. Ich möchte aber mehr leisten, als bloss die Resultate unserer wissenschaftlichen Tätigkeit meinen Zuhörern mitzuteilen; daher beabsichtige ich, im Laufe der Vorlesungen mit den rein wissenschaftlichen Darstellungen erstens Angaben über die Forscher, deren Leistungen berücksichtigt werden, und zweitens Beschreibungen der betreffenden Anstalten so zu verweben, dass ein möglichst ausreichendes Gesamtbild erzeugt wird, woran man zugleich die Leistenden und das Geleistete wird erkennen und ermessen können.

Für die von mir an der Universität zu haltende öffentliche Vorlesung, die unter dem Titel "Der Mensch in seiner Stellung in der Natur" angekündigt ist, soll eine gemeinverständliche Darstellung gewählt werden. Der Mensch wird vom Standpunkte des Naturforschers aus betrachtet, das heisst, es werden die Vorgänge seiner Entwicklung und die Eigentümlichkeiten seines Baues mit Bezug auf die Anpassung an die Lebensbedingungen seiner Existenz behandelt. Wir wollen uns also nur gelegentlich mit der phylogenetischen Entstehung des Menschen und mit der Ethnographie beschäftigen. Durch die Betrachtung des reichen Materials von einem etwas ungewöhnlichen Standpunkte aus wird unser Interesse angeregt, und es wird auch die Konkurrenz mit anderen, verwandten Vorlesungen in vorteilhafter Weise vermieden.

Die gegenwärtige Gelegenheit eignet sich dazu, einige allgemein gehaltene Betrachtungen über die Lage der Naturforschung in Amerika Ihnen vorzulegen, damit sie einen klareren Begriff von dem jetzigen Zustande der Wissenschaft jenseits des Meeres sich bilden können. In der Geschichte der Wissenschaft bei uns lassen sich, wenigstens für unsere unmittelbaren Zwecke, drei Perioden unterscheiden: erstens die Periode der Colleges; zweitens die der Universitäten; drittens die der Forschungsanstalten.

Die erste Periode, die der Colleges, dauerte bis etwa 1870. Das College steht höher als das deutsche Gymnasium. Da es seinem englischen Vorbilde nachgemacht ist, so vermittelt es nur die allgemeine höhere Bildung und versucht gar nicht, Fachgelehrte zu erziehen. Unsere Colleges lassen sich mit den deutschen Universitäten direkt nicht vergleichen.

Selbstverständlich ging es in den amerikanischen Kolonien während des siebzehnten Jahrhunderts ziemlich kümmerlich zu, doch fingen die Kolonisten sehr bald an, sich mit dem höheren Unterricht zu beschäftigen. In Massachusetts fand die Ansiedlung 1620 statt. Sechzehn Jahre später erfolgte die Begründung von Harvard College. Seitdem sind die Colleges sehr zahlreich geworden und sind immer stark besucht worden. Daher ist es gekommen, dass Amerika eine sehr bedeutungsvolle, überall verbreitete Klasse von Gebildeten hat, die die Hauptrolle in unserem ganzen Leben spielt, weil sie die grosse Mehrzahl der Führer in allen Berufen liefert. Sie gewinnt stetig an Einfluss und Bedeutung. Aus ihr stammt die Hauptunterstützung aller höheren öffentlichen Bestrebungen, aus ihr stammt die Mehrzahl der wissenschaftlichen Stiftungen.

Die Colleges beschäftigen sich sehr wenig oder gar nicht mit der Erziehung von Forschern. Es fanden sich aber trotzdem, besonders im neunzehnten Jahrhundert, einzelne tüchtige Gelehrte, die sich meistens selbst ausbildeten. Ich erwähne nur Bancroft und Lowell, Dana und Hall, Rush und Dalton, Leidy und Wyman, Young und Asa Gray. Wie hat das sich geändert! Bald wird ihre Zahl der in Deutschland gleich sein und diese Forscher werden unter günstigen Verhältnissen arbeiten. Die Verbesserung begann mit dem Erscheinen von Louis Agassiz in Amerika, des deutsch geschulten schweizerischen Naturforschers. Agassiz war einer der genialsten Menschen des neunzehnten Jahrhunderts und wusste in Amerika schnell ein seitdem sich nicht nur erhaltendes, sondern auch immer vergrosserndes Interesse für die Naturforschung zu erwecken. Als er das "Museum der vergleichenden Zoologie'' 1859 in Cambridge begründete, haben viele gemeint, er leide an Grössenwahn und sei ein Träumer; aber sein Traum hat sich verwirklicht, und das ''Agassiz-Museum'' ist nicht nur ein grosses von Weltbedeutung, sondern auch der Massstab für viele anderweitige amerikanische wissenschaftliche Institute geworden.

Unsere zweite Periode, die der Universitäten, begann in den siebziger Jahren des vorigen Jahrhunderts, als zwei hervorragende Führer zwei Universitäten, die sich als ebenbürtige und gleichwürdige den europäischen Universitäten an die Seite stellen lassen dürften, aufzubauen anfingen. Diese Führer waren der Präsident Eliot von der Harvard University in Cambridge-Boston und der Präsident Gilman von der Johns Hopkins University zu Baltimore. Ihre schwierige Aufgabe haben sie glänzend gelöst. Sie erreichten ihr Ziel dadurch, dass sie Post-graduate Schools gründeten und weiter entwickelten, die, etwa wie die deutschen Universitätsseminare, die Aufgabe haben, Studenten zu selbständigen wissenschaftlichen Arbeiten anzuleiten. Viele andere wirkliche Universitäten sind entstanden, obwohl sie bis jetzt untereinander sehr ungleich geblieben sind. Die weniger entwickelten betrachten sich mit Recht als Kinder, die mit den Jahren sicherlich erwachsen werden. Es wird voraussichtlich nur wenige Jahre dauern, bis wir in den Vereinigten Staaten über fünfzig gut entwickelte Universitäten haben werden. Ein Anfänger, der Naturforscher werden will, kann in Amerika die erforderliche Erziehung geniessen; doch möchte ich den jungen Forschern immer noch wenigstens einen Teil ihrer Studien in Deutschland zu machen anraten.

Die dritte Periode, die der Forschungsanstalten, hat keinen so bestimmten Anfang, weil die Anstalten zum Teil langsam entstanden sind; doch können wir sagen, dass diese Periode mit diesem Jahrhundert anfängt. Von den betreffenden Anstalten ist die Mehrzahl mit Universitäten verbunden—im letzten Jahrzehnt sind grosse Laboratorien überall entstanden, wovon mehrere nirgendwo übertroffen werden. Die Lehrer, die in denselben arbeiten, wissen, dass es unumgänglich ist, gute Untersuchungen durchzuführen, wenn sie auf ihrer akademischen Laufbahn vorwärtskommen wollen. Zu gleicher Zeit sind mehrere unabhängige Forschungsanstalten gestiftet worden. Ich erwähne die drei kolossalen Museen für Naturgeschichte zu New York, Pittsburgh und Chicago, das Rockefeller-Institut für medizinische Forschung, mehrere Stiftungen zur Untersuchung des Krebses, die zahlreichen von der Carnegie Institution zu Washington geleiteten Spezial-Laboratorien, das Wistar Institute zu Philadelphia, das Marine Biological Laboratory zu Woods Hole u. a. m. Wahrlich, an Gelegenheit und Mitteln fehlt es nicht!

Ausgezeichnete und glänzend dotierte Bibliotheken haben wir schon, und sie werden stetig reichhaltiger. Wir machen von denselben um so grosseren Gebrauch, als die Bücher sehr leicht und schnell zu bekommen sind.

Zwei sehr charakteristiche Eigenschaften der Amerikaner tragen wesentlich zur Förderung der Wissenschaft bei. Es handelt sich erstens um die Gewohnheit des gemeinschaftlichen Unternehmens und zweitens um die hoffnungsvolle Stimmung. Diese Eigenschaften verdanken wir unserer kolonialen Entwicklung.

Die Vereinigten Staaten sind aus dreizehn unabhängigen Kolonien entstanden. Die ersten Kolonisten fanden überall grenzenlose Urwälder. Da musste jeder für sich sorgen und selbst alles leisten, was zu der Neuerzeugung der Zivilisation nötig war. Sogleich entwickelte sich ein starker Individualismus, der unter uns erhalten bleibt. Aber diese selbstbewussten Menschen waren grossen Gefahren ausgesetzt. Dadurch wurden sie häufig gezwungen, sich zur gemeinschaftlichen Verteidigung zu vereinigen. So entstand die Gewohnheit der freiwilligen Kooperation. Wir vererbten ein starkes Selbstgefühl und eine Neigung zum gemeinschaftlichen Zusammenwirken. Die Verschmelzung dieser scheinbar feindlichen Bestrebungen zu einer einheitlichen Macht ist das Hauptmerkmal der Amerikaner. In dieser Macht findet die Demokratie zugleich ihre Rechtfertigung und ihre Befriedigung. Dieselbe Macht hat die Wissenschaft gefördert; denn durch freiwillige Kooperation sind die vielen Fachzeitschriften fast ohne Ausnahme entstanden. Der Kooperation verdanken wir wichtige Unternehmungen und die schöne Bereitwilligkeit, gegenseitig sich bei schwierigen Untersuchungen zu unterstützen; der Kooperation verdanken wir die Bildung und das Gedeihen der zahlreichen Nationalen Fachgesellschaften, die alljährlich während der auf Weihnachten folgenden "Convocation Week" tagen. Diese Sitzungswoche haben wir durch Kooperation von den Universitäten abgewonnen.

Um die bei uns herrschende hoffnungsvolle Stimmung zu erklären, muss man den Hauptbeitrag berücksichtigen, den wir fast unbewusst zur Lösung des Problems der menschlichen Gesellschaft geliefert haben. Dieser Beitrag ist eine Entdeckung, die ja sehr einfach und naheliegend war und doch erst durch die in Amerika obwaltenden Verhältnisse sich unserem Erkenntnisvermögen offenbaren konnte. Wir haben durch Erfahrung entdeckt, dass die Mehrzahl der zu uns herüberkommenden Einwanderer ihre volle Leistungsfähigkeit nie entwickelt hatten, und zwar deshalb nicht, weil ihr Verstand weniger in Anwendung gekommen war, als er es hätte gut ertragen können. Der Taglöhner wird bei uns ein Gewerbearbeiter, der Gewerbearbeiter ein Geschäftsmann, und der Geschäftsmann erweist sich eines noch höheren Berufes fähig. Für den Staat sind diese unaufhörlich fortgehenden Umwandlungen von der grössten Bedeutung, denn durch dieselben wird eine Verschwendung der Menschen vermieden; denn es ist eine Verschwendung, wenn eine Nation den Vorrat an menschlichem Verstand nicht vollkommen ausnutzt. Ein Staatsmann darf nie vergessen, dass die Menschen der Hauptschatz des Staates sind. Wir können hier bei diesen Überlegungen nicht verweilen, und gehen daher unmittelbar zum Schlusse über; hauptsächlich durch das stetige Vorwärtskommen wird die allgemeine Stimmung hoffnungsvoll.

Der typische Amerikaner erträgt oft unangenehme Zustände mit einem Gleichmut, der einen Europäer ins Staunen versetzt, aber nur, weil der Amerikaner die sichere Überzeugung hegt, dass die Übelstände mit der Zeit überwunden werden. So geht es mit unseren wissenschaftlichen Anstalten: zuerst oft nur der bescheidene Anfang, dann die grossen Hoffnungen, endlich die Erfüllung.

Daraus folgt, dass die Einheitlichkeit bei uns gar nicht in den Universitäten und den wissenschaftlichen Instituten, sondern nur in den Gesichtspunkten, in der Gemütsstimmung und in dem Seelenzustande zu ersehen ist. Wir haben in den östlichen Teilen unseres Landes eine Anzahl von vorgeschrittenen Universitäten; im Westen kommen gute und auch weniger entwickelte Universitäten vor. Hier und da findet man nur geringe Anfänge. Die University of Minnesota verfügt auch jetzt hoch über das nicht grosse Gebäude, womit sie anfing, und es leben noch Professoren, die an ihrer Gründung teilnahmen. Dieses Jahr aber hat die University das grösste und vollendetste anatomische Institut der Welt eröffnet. Es stehen da zwei Denkmäler:—der "Erwartung" und der "Erfüllung" gewidmet.

Vor vierzig Jahren entschloss sich ein zwanzigjähriger Amerikaner, sich der Wissenschaft zu widmen. Bald erkannte er, dass es damals in Amerika einem angehenden Naturforscher sehr an Gelegenheiten und Unterstützung fehlte, daher entschied er sich, nach Europa zu gehen. Er fand in Deutschland die heiss ersehnten Lehrer und Anstalten, und so kam es, dass er durch seine deutsche wissenschaftliche Ausbildung ein Untertan des deutschen Geistes geworden ist. Nach einigen Jahren begab er sich wieder in die Heimat. Sechsunddreissig Jahre hindurch hat er—wie andere seiner Landsleute—unaufhörlich das deutsche Ideal der Forschung durch Wort und Tat in Amerika zur Geltung zu bringen versucht. Dass sein Streben nicht vergebens gewesen ist, wagt er daraus zu schliessen, dass er jetzt vor Ihnen als Austauschprofessor steht. Seine Ernennung zu dieser Professur ist ihm eine nicht zu überschätzende Ehrung. Seine Anerkennung kann er in diesem Moment nur dadurch zum Ausdruck bringen, dass er die ihm von Ihnen auferlegten Pflichten gewissenhaft und nach besten Kräften zu erfüllen verspricht.

Heute aber möge es mir gestattet sein, an erster Stelle Ihren Majestäten für die hohe Auszeichnung Allerhöchstihrer Gegenwart ehrfurchtsvollsten Dank auszusprechen. Auch danke ich Seiner Exzellenz dem Herrn Kultusminister und seinen Räten sowie Eurer Magnifizenz für die mir geschenkte Aufmerksamkeit. Allen meinen geehrten Kollegen und, last not least, den deutschen Kommilitonen wärmsten Dank mit dem Wunsche für ein gutes und erfolgreiches Semester.

Charles Sedgwick Minot

THE MEETING OF THE AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE AT CLEVELAND IN 1853[1]

The twenty-eighth of July was the day appointed for the meeting of the American Association for the Advancement of Science. During the week after that date, Cleveland, the Forest City of the West, teemed with an unwonted convocation. Steamboats and railroad trains poured forth in her shaded streets groups of enthusiastic savants, bearing hither, as to a shrine, the fruits of their two years' thought and labor. In answer to a formal summons from the appointed hierarchs, the sunny South, the cold, contemplative North, the commercial East and the wilderness West sent forth their "representative men," their observers, their experimentalists and their philosophers, to give and to gather the unseen wealth of thought. Happy is the day when our geologists and naturalists, our chemists and engineers, our astronomers and mathematicians, our geographers and ethnologists, our physiologists and botanists, give to each other the right hand of fellowship, and come to know each other as coworkers in one great labor. It is a sight to gladden one's heart, when the modest and shrinking man of thought or genius, through the long years a lone laborer in his better than Californian or Australian mines, at last meets his compeers and finds the warm welcome and recognition which had been his early ambition, but had long ceased to be his hope. It is a moment when philosophers show forth the deep and strong human heart that is in them, when, after a long seclusion, they grasp anew the hand of such friendship as springs from sympathetic tastes and mutual respect.

Its constitution declares that "the objects of the association are, by periodical and mi-

[1] From *Putnam's Monthly*, Vol. 11, September, 1853, No. 9, p. 319 et seq.

gratory meetings, to promote intercourse between those who are cultivating science in different parts of the United States; to give a stronger and more general impulse, and a more systematic direction to scientific research in our country; and to procure for the labors of scientific men increased facilities and a wider usefulness." Collegiate professors, and the few who, scattered through the industrial and professional walks of life, have power and leisure to do something positive in the interpretation of nature, chiefly constitute this nomadic association. The sympathetic bond of scientific investigation, of endeavor at some point to transcend the line which divides the known from the unknown in nature and in man; this union of purpose is that central thread of connection which makes a unity of elements individually so diverse. This association is the U. S. Congress of Science, but one without parties or patronage, and in which all departments of genuine knowledge and philosophy find recognition and representation. In this convocation many of our noblest minds display their stores of rugged wealth, and genius here exhibits the pearls it has drawn from the depths of truth's great ocean. Calmly and soberly, with a style perhaps void of eloquence and grace, yet earnest, direct and truthful, does the inquisitor of nature tell of the confessions he has extorted from the animate and inanimate realms of the created. Feeble minds at times will expound crudities and venture rash flights, but some voice of sage philosophy or cool experience is ever at hand to correct misconceptions or cripple a too lawless wing. A generous and delightful spirit of amity has hitherto prevailed, almost without interruption, in these meetings, and great would be the pity and the shame if a less tolerant and courteous feeling should ever enter an assemblage devoted to objects so noble and elevating. He is more of an egotist than a true student of nature who can engage in fierce contention on points of science.

In September of 1847 "The Association of American Naturalists and Geologists," while assembled in Boston, decided to expand its organization so as to bring the entire field of positive science within its compass, and accordingly resolved itself into the "American Association for the Advancement of Science." The geologists created by the great necessity for geological exploration over our magnificent domain, and the naturalists engaged in parallel and often associated labors, found it necessary to band together, and at appointed meetings to learn from each other the results of their respective labors. As this association grew vigorous and compact the need of a broader basis for operations was felt, and at last led to that expansion which has made for us an association, organized on the same principles, and for the same ends, as the British Association for the United Kingdom, and the earlier general association for Germany.

The instauration meeting of this new body was held in Philadelphia, during September, 1848. A constitution was then adopted, which, with some modifications, is still in force. The idea was too new to meet with full success, and accordingly, that meeting, of four days duration, exhibits less of interest than the subsequent ones. Yet much was done towards making generally known what the objects proposed really were.

The second meeting was held in Cambridge during August, 1849. The venerable shades of Harvard swarmed with philosophers, and new voices resounded within her time-honored walls. A full attendance, numerous communications of interest and importance, many social courtesies, and a harmony which knew no check, made a *tout ensemble* held by many in delightful memory.

Next was appointed and held a semi-annual meeting at Charleston in March, 1850. Here several elaborate papers on geological and botanical subjects were presented, and the proceedings exhibited much variety. Unfortunately a gleam of middle-age intolerance dared to intrude and to foment some animosity under the cloak of religion. But we trust that the time is past when science need fear boldly to speak out its truths, however unwelcome or provocative of the *odium theologicum*. We hope the drama of Galileo will under all forms and disguises be hereafter hissed from the stage.

The next meeting was held for a week during the latter portion of August, 1850, at New Haven. The quiet and beautiful city of elms extended a cordial greeting to the scientific soldiers who responded at the yearly roll call. The communications read were numerous and of marked interest, especially in the department of general physics. A semi-annual meeting was then appointed and in due time held at Cincinnati, during the second week of May, 1851; at which communications on geological subjects predominated. The total number of papers was about one half of that at New Haven. The most striking incident was the triumph of Professor Mitchell's method of recording astronomical observations.

The succeeding annual meeting was held at Albany, and was probably the most interesting of the series. The number of members in attendance (doubtless exceeding 300), the variety, interest and scope of the papers presented (being 134 in number), and the indefatigable hospitality of the Albanians, made up a week of continuous mental vitality and social ovation. The subdivision into sections was more complete than it had been before, and each section had full occupation.

It was there resolved to accept the invitation by the corporation of Cleveland to hold the next meeting in that city, commencing on the third Wednesday of August, 1852. The prevalence of cholera and other diseases in the west just prior to this date induced the standing committee to postpone the proposed meeting, so that no assembling of the association occurred until that which is just concluded. After fully canvassing the convenience of all concerned, it was decided to meet in Cleveland for the week following July 28, 1853. This meeting lasted five working days, and progressed with increasing interest, the number of papers being over eighty. A very decided preponderance of physical subjects was found to prevail, the departments of natural history and geology not being as strongly represented as usual. The non-attendance of Professor Agassiz, the Rogers, Dana, Hitchcock, Foster and other leading spirits, who always have ample contributions, was a deficiency seriously felt, and gave a too partial character to this meeting, which was much regretted. We trust that this is not to be construed into a lack of interest or of fealty on the part of the geologists and naturalists, and we hope that this association, their own foster-child, is not through their defection to become lop-sided and incomplete. That some disaffection exists we are well aware, but we would say in all earnestness, let not this be the means of dissevering this natural unit; rather let the next meeting be entered into with the hearty concurrence of all, and with the thorough resolution to waive all discordant memories, and at least to try again fairly to execute the fundamental idea of this association. We believe such an effort will be made, and that it will fully succeed. The Cleveland meeting came at a time inconvenient for many, nor was the place central; which, with the loss of interest consequent on the two years' interval, will explain the inferiority of this meeting to that held in Albany, without supposing any positive secession. Washington, the next point of meeting, is a place where all sections of the association should array their full strength and present the complete federation of the sciences in a representative congress. The last Wednesday in April, the soft, delightful month of flowers and foliage, is the appointed day of convocation. With congress in session, and nature in gala array, with a certainty of welcome and hospitality, with our capitol lions to be seen and our capitol orators to be heard and to hear, there would seem to be enough to insure a full and fruit-bearing meeting.

The election of officers at the Cleveland meeting resulted in the choice of Professor Dana, for president; Professor J. Lawrence Smith, for general secretary; Professor Joseph Lovering, of Cambridge, for permanent secretary, and Dr. Elwyn, for treasurer. These officers elect will enter on their duties at the next meeting.

The six volumes of proceedings of this association at the six meetings first held exhibit a rich aggregate of research and suggestion covering a large part of the scientific specialities which have been cultivated among us. It is indeed lamentable that so large a portion of the most important communications made are not included in the proceedings, being, through the delays and neglect of their authors, entered as "not received." It is also matter of much regret, if not of complaint, that the presidents, with the exception of Professor Bache (who is the most occupied of all), have not furnished their annual addresses for these volumes. To us it seems incumbent on the president to make his retiring address an elaborate production, in which the general progress of science during the year shall be reviewed; or in which some large and positive subject of scientific interest and importance shall be thoroughly and yet popularly treated. For instance, we should have liked to have heard from Professor Agassiz a summary of what has been done, and what is still desired, in the natural history of North America. Or still better would we have relished from this highest source, a discourse on the intellectual element in organic structure. Why, too, should not Professor Pierce unfold a year hence, how America needs a real university, and what such a university should do if organized. Some *positive* subject should be chosen, or else the annual address should be a systematic *exposé* of what has been done during the year, as it usually has been made by the British Association presidents.

We are happy to record the generous action of Charleston, Cincinnati, Albany and Cleveland, in assuming the expenses of publishing their respective volumes of proceedings. The citizens or the corporations have in these instances taken on themselves the burden of publication; which generosity is alike an honor to them and to the association. This body has no source of income, except the fees of members, amounting only to $2 per annum, or $3 with the annual volume of *Proceedings* (just changed to $1 fee and *Proceedings* at cost). The liberality it has experienced is thus very fortunate, especially when we remember that the possession both of wealth and of philosophic lore rarely falls to the lot of the same individual. With all its utilitarian biases in these days, science rarely enriches the coffers of its cultivators, so that truly original researches are still well-nigh as unremunerated as in the wretched days of patrons. The moneymakers are usually two or three removes from the prime investigators whose search is for principles. Wide indeed is the tract between Castalia and Pactolus.

As the presidents and acting officers of this association are all men in whom the public has a certain right of property, and as they will well bear being delineated, it seems proper here to present, for such as may be strangers to them, a series of outline sketches of these post-of-honor-bearers in this migratory congress.

The first president was W. C. Redfield, Esq., who officiated at Philadelphia. A noticeable man, too, is Mr. Redfield. One would scarcely expect to find, under so placid and venerable an exterior, a spirit living in storms and hurricanes. Yet it is true that his keen eye is steadily bent on the wind bags (how invaluable had he been to Ulysses!), nor can a breeze indulge in any gyrations or irregularities but he is sure to put black marks against it in the books. Long has Mr. Redfield been a weather sentinel, and meteorology owes him much, both in the field of observation and in the far higher domain of speculation. But for a few live-minded men of this cast, rational meteorology would long since have been dead and buried in figures, which dull men can accumulate, though to interpret them requires the keen eye of subtle but patient reasoning. If, as is likely, Mr. Redfield is wedded to his theories, there is no lack of counter-theorists to battle his unproved positions, and in rather a stormy temper too; a fault which seems quite to beset our weather-seers, as if the shrewishness of our climate communicated itself to those who supervise its whimsicalities. Mr. Redfield is, moreover, a good geologist, having specially studied the fossils and fossil raindrops of the Connecticut valley red sandstone.

The second president was Professor Joseph Henry, the secretary of the Smithsonian Institution, who presided at Cambridge. He is a hale and rather portly man, with a face alternating between abstraction and a very kindly consciousness, and looks as if he had a mission to work for man another score of years. He was born an experimental philosopher, and so lived at Albany and Princeton, until he was elected to his present administrative post. To his discoveries in electricity the telegraph owes its practical development, and we verily believe that with industry on his part, and a fair chance thus to apply himself, electrical science in all its fields might have owed him more than it does to Faraday. But this hope was extinguished under the southern tower of the Smithsonian Institution. There he is busy with what others, doubtless, could do as well; and thus is left undone what none other could do at all. This is a new instance of taking a man of proved abilities in one sphere to do what belongs to another and quite dissimilar one for which he has no birthmark. We ought to learn that men are of most value when doing that for which they have a special faculty, and it is a fair question whether Professor Henry, doing that for which nature intended him, would not during his life effect more in advancing science than the Smithsonian Institution in its aggregate existence is likely to do. High as this institution stands as a practical fact, and useful as it is and will be, if it is to extinguish the experimental researches of Professor Henry, we could fain say, give us back the man and let the institution go. Professor Henry lacks but mathematical training and energy of purpose to do something greater than has yet been accomplished among us in the domain of physical science. Will he do so? is the question. Facts within our knowledge assure us that this must and will be.

Next on the list of presidents comes Professor A. D. Bache, the superintendent of the Coast Survey, who presided at Charleston, New Haven and Cincinnati. He is a fortunate man in having found exactly the place for which nature and training have best fitted him. His quick eye, facile perception and actual attainments in science and in the knowledge of men make him the eminently able administrative man which he is fully admitted to be. Heading his class at West Point, encountering as an officer of engineers the stern actualities of engineering; as a professor and college president in Philadelphia achieving eminent success, he grew in that stature of mental training and experience which makes his eminence and usefulness in his present post a natural result. It is a rare thing to find so fortunate a combination of administrative and scientific talent, nor do we believe the country possesses another man who could so well thread the complications incident to Professor Bache's position. He is clearly Franklin's grandson. Whether, if permitted the requisite leisure, he would strike out and execute any great invention, discovery or research, is a question not easily answered; for though his original researches are highly creditable, especially in discussing the tides, they are, of course, only such as were compatible with his incessant life of action. The deeply reflective element whence the greatest achievements spring, has in him, as in most of our best men, been kept in abeyance by the intense externality and practicality of American life.

Professor Louis Agassiz was the next president, acting as such at the Albany meeting. He is a man of highest genius, who does great things quite naturally and yet with intense labor. Take him all in all, he towers quite above every living naturalist, and may not inaptly be called *Cuvier Junior*. His physique is of the noblest kind, and his ample forehead gives token of the mind within. He comes to us from the Alps, an Alpine man. Trained under Cuvier, and by him honored as residuary legatee to a large field of research; he has been an enthusiastic and most fruitful laborer in ichthyology, paleontology, glacial geology, animal classification, embryology, and especially has he carried new light among the inferior orders of animate beings. His work on Fossil Fishes has recently been crowned with the Cuvier medal, then given for the first time, though founded by Cuvier, who died in 1832. He was professor of natural history in the Swiss university at Neufchâtel, until in 1846, when he came to this country, and was soon made professor in the Lawrence Scientific School, Harvard University. Here he has done distinguished service to natural history, and has been continuing the great labors of his life. A large cabinet has grown up around him, where he is buried in a multitude of special and general investigations, which unfortunately he rarely puts in form for publication, leaving scores of important researches and discoveries quite unrecorded. He much needs collaborators and reporters, to save his labors from oblivion. Among other herculean toils, he is maturing, and will in time present to the world, the broadest and completest classification of animated nature which has been made. From such a man was the discourse by the retiring president, this year, to have come, had not ill health prevented his attendance. We have doubtless thus been deprived of some of those exhilarating generalizations and enthusiastic bursts which so characterize his genius and indicate its superiority to the mere talent of the ordinary investigator or descriptive naturalist.

The president now officiating, and who presided at Cleveland, is Professor Benjamin Peirce, of Harvard University. As we look on his floating locks, furrowed brow, thin face and figure, and especially his clear, deep eye, it is not difficult to recognize the first American mathematician and physical astronomer. His mind plays football with transcendental functions, and runs algebraic gauntlets with a facility scarcely inferior to that of Cauchy, the preeminent mathematician of France, who, declining to swear by Louis Napoleon, was a few months since ejected from his government professorship in Paris. (Why will not some millionaire invite M. Cauchy to America, providing for him as Mr. Abbott Lawrence did for Professor Agassiz?) Professor Peirce is an excellent refutation of the usual slip-shod idea of a mathematician. He is a most interesting, earnest and cultivated gentleman, of marked kindliness and geniality, and excellent company for any man of sense. Scarcely could a less genial man so long make part of that most high-toned, refined and cultivated circle of college society in Cambridge, without at least an external exhibition of the humanities of culture and of life. So fully has the professor president mastered the perturbations of the planets, that he may be said to have put these wanderers under centennial bonds to keep the peace. When the world was all agog with Le Verrier's discovery of Neptune, through the perturbations of Uranus, Professor Peirce publicly declared that the planet discovered was *not* the planet called for by Le Verrier's theory; a bold saying that was, and we then thought a rash one, but he was quite right, as the daily confirmation of the lamented Walker's Ephemeris fully proves. Once, too, he was wrong; but when he found his error he was prompt to confess and disclaim it as publicly as possible: a nobler thing than convicting Le Verrier of oversight. Professor Peirce has long been a sort of backbone to the physical astronomy of the country, as has of late been shown in his services to the new Nautical Almanac; and we hope he may long survive to fill this post of labor and of honor.

At the fourth meeting, the only salaried officer of the association, that of permanent secretary, was created, and a salary of $300 per annum established, the term of office being three years. Professor Spencer F. Baird, of Dickinson College, Pennsylvania, now the Natural History Secretary of the Smithsonian Institution, was chosen to this new post. His duty includes arranging for reports of proceedings, the issuing of circulars to members, nearly all the current correspondence, and the charge of publishing and distributing the volumes of proceedings. The smooth working of the business matters of the association depends very much on the skill and fidelity with which the duties of this office are discharged; and it is fortunate that one so competent in every respect was chosen to it. Professor Baird was a favorite pupil and intimate friend of Audubon, and has made special attainments and copious collections in ornithology and ichthyology, besides a general study of natural history. With a physical and mental vigor developed in collecting specimens, and still unscathed by time, he unites excellent business qualities, and thorough acquaintance with publishing. He is the American editor and chief translator of the Iconographic Encyclopedia, which, with his duties in publishing and distributing the Smithsonian contributions, has peculiarly qualified him for the labor of editing and publishing the association proceedings. Nor is there any one whose intimacy with the scientific men in this country is more general and desirable. His youth and mental vitality give assurance of many years of effective service still in those labors where he is already so much at home.

The general secretary of the association is Professor J. D. Dana, of Yale College, if one so cosmopolitan in knowledge and journeyings can properly be assigned to a locality. (Professor St. John, of Cleveland, acted in this capacity at the last meeting, as Professor Dana was unable to attend.) He is one of the solid human columns on which our national scientific reputation may safely repose. Beneath a kindly and modest exterior, he has managed to amass treasures of accurate knowledge, sufficient to stock many ordinary heads to repletion. He is indeed a man of wonderful scientific learning for one still in his fresh manhood; and this learning is made prolific by a philosophic and reasoning mind. Among American mineralogists he is *facile princeps,* as evinced by his treatise on mineralogy; and we much doubt if in this branch the world can show his equal. The natural history of the Wilkes Exploring Expedition, which he accompanied, owes him a burden of obligation which will long be recognized by naturalists. Nor is it probable that a higher authority can be cited in respect to volcanic phenomena. These pipes of the Titans he has sniffed and scrutinized "the world around," having indeed carried on quite a flirtation with Pelée in the Sandwich Islands. His researches among the coral formations, and his writings thereon, take the very highest rank, and his monographs on Crustaceæ, Zoophytes and Medusæ would alone entitle him to the highest standing in natural history. As one of the chief editors of the *American Journal of Science* he is abundant in good deeds and good works. Professor Dana is not perhaps a man of the highest genius, but he will leave the world decidedly the wiser for his labors and researches, even though he do no more in the future. But we trust he will through many years be spared to apply his well-trained powers to the boundless researches ever inviting them.

Dr. A. L. Elwyn, of Philadelphia, is now, and has been nearly from the first, treasurer of the association. His distinction lies not in any particular department of science, but he is much interested in promoting it, and ever ready to aid its advance. He has paid much attention to agriculture, and has a model farm, on which he is laboring to give a scientific direction to the too empirical processes of the routine farmer.

And so ends our talk of the retired presidents, and actual officers, of this scientific body. We might dwell on the functions of the standing committee, which is its governing council of elders, but this would possess very little general interest. It is on nomination by the standing committee that new members are elected, and such nominations may be procured through any actual member, by any person really engaged in prosecuting positive science.

The subject of scientific advancement in the United States is one of peculiar interest and importance. The work which science has to do, in cultivating the vast field of descriptive knowledge presented by our still new continent, in ministering to all the common arts of life, in evolving the grand principles and mysteries of nature, and in nurturing a higher and more beneficent spiritual faith; this is a work of such transcendent moment, that our loftiest conceptions are but feeble images of the unseen reality. The whole surface and substance of modern life is undergoing a ceaseless transformation, through the manifold ministries which science is daily embodying in the forms and operations of manufacture and of art. Though no prophecy reveals what the future may have in store, it is still the confident anticipation of reason, that new wonder-workings will not soon cease to flow from the *cornucopia* of speculative and experimental science. When we reflect how few are cultivating philosophical researches in our midst, and compare this petty band with the mighty results to be achieved through their labors, and the limitless harvest waiting for reapers, our spontaneous aspiration is, without stint, and by all legitimate means, to increase the numbers and strengthen the arms of this too feeble fraternity.

America has not yet attained that scientific maturity which must, we hope, ere long entitle her to claim a foremost rank in the world-federation of philosophy. Preeminent in all the mechanical and practical functions of living and of labor, we lack that deeper element of digested learning and reflective culture which will give continuous vigor and systematic power to our scientific progression. Our low tone of mathematical culture precludes us from all access to some of the richest placers of physics, and throws many of our ablest minds on a subtle and tricksy sleight of mind, in researches where the well-furnished investigator would cleave a sure, straight road to the end. With leisure and wealth will come an accession of solid strength and deliberate direction to our too spasmodic vaultings into the realms of discovery. When the man of science is relieved from the excessive labor, and stupefying routine of the professorial function, when research becomes a self-sustaining vocation, and when approved genius is permitted to address all its fire and energy to elaborating and verifying its originations; then American science, erect and self-reliant, will tower upward into a column of true national majesty, more honoring to us, and more diffusive of blessing to man, than even our glorious constitutional fabric. Speed that day, whoever can!

SCIENTIFIC NOTES AND NEWS

The medal of the Society of Chemical Industry was presented to Sir William Crookes at a dinner in London, at which about 150 members and guests were present. The retiring president of the society, Dr. Rudolph Messel, F.R.S., made the speech of presentation, to which Sir William Crookes replied.

At the last meeting of the board of trustees of Cornell University, Mr. Henry R. Ickelheimer, '88, of New York, a member of the board, expressed a wish to give the university a statue of Dr. Andrew D. White, and his suggestion met with the cordial approval of the board. He proposed to give the commission to Mr. Karl Bitter.

The Buchanan medal awarded by the Royal Society to Col. William C. Gorgas, the chief sanitary officer of the Panama Canal Zone, was formally presented at the anniversary meeting of the society on November 30.

Dr. W. J. Holland, the director of the Carnegie Museum, has returned to Pittsburgh after three months' absence in South America. He installed in the National Museum at La Plata a replica of the Diplodocus presented by Mr. Carnegie to the Argentine Republic. He was tendered a banquet by the Academy of Sciences at La Plata, upon which occasion he was made an honorary member of the academy in the section of the natural sciences. On the eve of his departure for the north, he was tendered a banquet at Buenos Aires by the united faculties of the universities of La Plata and Buenos Aires.

President Henry Fairfield Osborn and Dr. J. A. Allen will represent the American Museum of Natural History at the Ninth International Congress of Zoology to be held at Monaco in March, 1913.

Sir Thomas Crosby, the retiring Lord Mayor of London, although eighty-two years of age, is preparing to return to the practise of surgery after laying down his official duties.

Mr. C. S. Orwin has been appointed director of the institute for research in agricultural economics at Oxford University.

Dr. G. Abetti has been appointed assistant astronomer in the Vatican Observatory at Rome.

Northwestern University will have as seventh Harris lecturer next spring Dr. J. S.

Ames, professor of physics in the Johns Hopkins University.

Dr. F. A. Pax has been appointed curator of the Zoological Museum of the University of Breslau.

Dr. Charles B. Davenport, director of the Station for Experimental Evolution of the Carnegie Institution, lectured upon "Heredity and Eugenics" before the Syracuse University Chapter of Sigma Xi and invited guests, on the evening of November 20. The chapter is planning for a series of public scientific addresses, of which this was the first, to be given during this college year.

Professor H. J. Webber, of Cornell University, will give in April a lecture on "Eugenics," for which Mrs. Huntington Wilson, of Washington, has given the university the sum of $100.

Dr. E. L. Thorndike, professor of genetic psychology, Teachers College, Columbia University, has given lectures on "Man's Original Nature," "Social Instincts" and other subjects at the University of Michigan, Northwestern University and the University of Illinois.

Mr. N. H. Darton, of the U. S. Geological Survey, presented an illustrated lecture to the New York Section of the American Institute of Mining Engineers at its November meeting. The subject was Structure of the Northern Anthracite Coal Basin relative to forms of folds. A map was shown in which the structure of the basin was represented by 100-foot contours.

Arthur H. Blanchard, professor of highway engineering in Columbia University, on November 25 delivered an address entitled "The Art and Science of Highway Engineering" at the celebration of Founder's Day at the Clarkson School of Technology.

Dr. James Woods McLane, a distinguished obstetrician, formerly dean of the College of Physicians and Surgeons, Columbia University, died on November 25 at the age of seventy-three years.

Dr. Wilhelm Ebstein, professor of internal medicine at the University of Göttingen from 1877 until 1906, died on October 22 at the age of seventy-six years.

The deaths are also announced of Professor Franz Kamienski, director of the botanical garden at Odessa, and of Dr. Arnoldo Minozzi, professor of chemistry in the Technical Institute at Padua.

Through the initiative of the medical department of the University of Pennsylvania the Rush Society has been established for the purpose of the diffusion by lectures of knowledge concerning recent advances in the medical and general biological sciences and in public hygiene. The objects are similar to those of the Harvey Society of New York. It is proposed to present during each academic year a program of not less than six or more than eight lectures. The first lecture will be given in January and arrangements are being made for three others before May 1. The program of lectures will be issued shortly. Lectures by Professor Theodore C. Janeway, of Columbia University, and by Professor M. J. Rosenau, of Harvard University, have already been arranged. At the meeting for organization of the society held on November 21, the following officers were elected: *President,* Richard M. Pearce; *Vice-president,* Alfred Stengel; *Secretary-treasurer,* William Pepper; *Councilors,* A. E. Taylor, A. C. Abbott, H. H. Donaldson.

The American Museum of Natural History has received from Mr. D. C. Stapleton the gift of valuable prehistoric objects in gold and platinum from the province of Esmeraldas, Ecuador, and the headwaters of the San Juan River, Colombia, and has placed the collection on exhibition in the South American gallery on the third floor. The objects show examples of casting and beating, of plating where copper has been covered with thin gold, of the union of two pieces of gold by welding and of the soldering of two minute surfaces in such manner that it is difficult to detect the solder. The objects in platinum are of most interest, as it is not known that this metal was ever worked, except in this locality, by a prehistoric people. Through the generosity of Mr. J. P. Morgan, Jr., the museum secured recently the collections of minerals and meteorites left by the late Stratford C. H. Bailey, of Oscawana-on-Hudson. Mr. Bailey had assembled representatives of nearly three hundred falls and finds of meteorites. At least twenty-two of these are new to the museum's already great collection. The endowment fund of the museum has recently received an addition of five thousand dollars from Mrs. William H. Bliss. Mrs. Bliss has been elected a patron of the museum in recognition of her gift.

The surgeon general of the army announces that preliminary examinations for the appointment of first lieutenants in the army medical corps will be held on January 20, 1913, at points to be hereafter designated. Full information concerning these examinations can be procured upon application to the "Surgeon General, U. S. Army, Washington, D. C." The essential requirements to securing an invitation are that the applicant shall be a citizen of the United States, shall be between twenty-two and thirty years of age, a graduate of a medical school legally authorized to confer the degree of doctor of medicine, shall be of good moral character and habits, and shall have had at least one year's hospital training as an interne, after graduation. The examinations will be held simultaneously throughout the country at points where boards can be convened. Due consideration will be given to localities from which applications are received, in order to lessen the traveling expenses of applicants as much as possible. The examination in subjects of general education (mathematics, geography, history, general literature and Latin) may be omitted in the case of applicants holding diplomas from reputable literary or scientific colleges, normal schools or high schools or graduates of medical schools which require an entrance examination satisfactory to the faculty of the Army Medical School. In order to perfect all necessary arrangements for the examination, applications must be completed and in possession of the adjutant general at least three weeks before the date of examination. There are at present thirty-five vacancies in the medical corps of the army.

It is stated in the *Yale Alumni Weekly* that a pictorial story of iron from the time the ore is mined until it has been transformed into the finished product, such as steel rails or sheet piling, was a special feature of an exhibit of Rogers, Brown & Company, at the convention of the American Foundrymen's Association held in Buffalo, N. Y. For many months experts in motion pictures worked under the supervision of Henry B. B. Yergason, of Rogers, Brown & Company; the result is pronounced one of the most complete series of moving picture films ever made of an industrial subject.

In spite of the decrease in the production of iron, the value of the total mineral production of the United States for 1911 reached the enormous figure of $1,918,184,384. Of this the value of the metals was $672,179,600, the remainder representing the non-metals. Coal led the list, with a value of $626,366,876; pig iron was second, with a value of $327,234,624; clay products third, $162,236,181; copper fourth, $137,154,092, and petroleum fifth, $134,044,752. These and other figures of production are discussed in an advance chapter from "Mineral Resources of the United States" for 1911, by W. T. Thom, of the United States Geological Survey. While the total value for 1911 is about $70,000,000 less than for 1910 it is greater than that of any other year except the banner year of 1907, when the $2,000,000,000 mark was passed. Indeed it is only in the last 13 years that the mineral output of the country has been above the billion dollar mark. Fourteen years ago, in 1898, it was only $724,272,854 and 10 years before this, in 1888, it was but a little over $500,000,000. In spite of the decrease in the total value of the mineral output in 1911, a considerable number of products showed a marked increase, 45 of the minerals for which statistics were collected by the Geological

Survey having increased in production, against 21 which showed a decrease. Thus, anthracite coal increased to the value of nearly $15,000,000; lead and zinc each increased more than $3,500,000; silver increased $1,750,000; petroleum more than $6,000,000; natural gas nearly $3,500,000, and sulphuric acid nearly $3,000,000. The products showing the greatest decreases were pig iron, more than $84,000,000; bituminous coal, about $18,000,000; clay products, nearly $8,000,000, and cement, $2,000,000, although the amount of cement produced was 1,750,000 barrels in excess of that produced in 1910.

An interesting fact in connection with the production of coal in the United States, according to the U. S. Geological Survey, is that in each successive decade the output is practically doubled. If the production of bituminous coal alone were considered, the record for the last fifty years would show an increase somewhat in excess of this ratio. The increase in the production of anthracite has been much less rapid on account of the limited area of the fields, the conditions under which the industry is carried on, and the restriction of the prepared sizes to domestic consumption. It has been estimated that the output of anthracite will reach 100,000,000 long tons annually before it begins to decline. The maximum production up to the present time has been 80,771,488 long tons. An increase in the annual production of bituminous coal may be anticipated for some time to come. The statistics of coal production in the past show that up to the close of 1865 the total output had amounted to 284,890,055 short tons. In the decade from 1866 to 1875, inclusive, the production amounted to 419,425,104 tons, making the total production up to the close of 1875, 704,315,159 tons. In the following decade, from 1876 to 1885, inclusive, the output amounted to 847,760,319 tons, somewhat more than double the total production during the preceding decade. At the close of 1885 the total production amounted to 1,552,075,478 tons, and the production during the ten years ended in 1895 was 1,586,098,641 tons, the total production at the close of 1895 amounting to 3,138,174,119 short tons. In the decade ended December 31, 1905, the total production amounted to 2,832,402,746 short tons, and the grand total from the beginning of recorded coal mining in the United States amounted to 5,970,576,865 short tons. The average annual production from 1896 to 1905 was 283,240,275 short tons; the average production from 1906 to 1911, inclusive, was 461,499,260 short tons, showing an increase of 178,258,985 short tons, or 63 per cent.

UNIVERSITY AND EDUCATIONAL NEWS

Mr. Peter Makoushin has founded at Tomsk, Siberia, an institution on a large scale, to be called the House of Science, intended to provide instruction of all kinds, including university courses.

By the will of Mr. Thomas Bartlett, Liverpool University receives £20,000 for scholarships for engineering students.

The South African Union has awarded five government scholarships in agriculture for study abroad. The holders of these scholarships will receive $750 per year during the three or four years for which provision is made. The successful applicants were obliged to pledge themselves to enter the service of the South African Union after completing their studies, and to remain in the service for at least three years at a salary not less than $1,500 per annum. Only sons of parents permanently domiciled in South Africa were eligible for the scholarships.

Plans for the new Gilman Hall of the Johns Hopkins University have been accepted by the trustees. The actual work of building will begin in the spring. Gilman Hall will be the largest building to be erected in the group at Homewood, the new site of the university. It will contain the library, seminary rooms for history, economics, philosophy and the languages.

Northwestern University has signed contracts for the erection of nine of the new dormitories which are to form a part of the residence quadrangle system in the proposed development of the campus, and the foundations of the buildings are now being laid. Five of these houses will be owned by fraternities, and will be gifts of the alumni to the university for the use of their respective chapters. The nine buildings will accommodate nearly three hundred men, and will be open to students in the Evanston schools and also to those in the professional schools in Chicago. Buildings to be completed within the next two years will cost about $350,000. Alumni have agreed to give about $222,000 of this sum for the construction of houses for their fraternities.

THE new household arts and science building at the College of Industrial Arts, Denton, Texas, which is now in the course of erection at an expenditure of over $75,000, will be completed in the early spring. This building will be devoted exclusively to applied science and art as they relate to the home. Provision has been made for laboratories of food chemistry, textile chemistry and experimental dietetics. Also rooms are provided for mechanical drawing and home architecture, including china painting, clay modeling, pottery and other phases of ceramics. An auditorium with a seating capacity of about 1,100 is also included. The formal opening in April will also be designed to celebrate the tenth anniversary of the college, and several noted scientific men will be invited to be present and make addresses.

THE Faculty of Arts and Sciences of Harvard University has established a degree with distinction in natural history. The work of candidates for this degree will be supervised by a committee consisting of the chairmen of the divisions of geology and biology. The requirements for this degree are eight courses in the sciences, at least six of which must be in the divisions of geology and biology. Of the courses so designated, not less than three must be in the middle or higher groups; and not less than one must be taken in each of the divisions of geology and biology.

IN the department of geology at the University of Chicago, Albert Dudley Brokaw has been made an instructor in mineralogy and economic geology.

MR. WILHELM MILLER has been appointed assistant professor of landscape horticulture at the University of Illinois. The name of the appointee was incorrectly given in a recent issue of SCIENCE.

IN the University of Manitoba, Winnipeg, Canada, the following promotions have been made: R. C. Wallace, Ph.D., D.Sc., to be professor of geology and mineralogy; R. K. McClung, D.Sc., to be assistant professor of physics; L. A. H. Warren, M.A., to be assistant professor of mathematics. The following new appointments have been made: R. W. Moffat, B.A.Sc., of the faculty of applied science of Toronto University, to be lecturer in masonry construction and drawing; E. E. Bankson, B.S., the University of Pittsburgh, to be lecturer in materials and hydraulics.

DISCUSSION AND CORRESPONDENCE

PROFESSOR DE GROOT ON AMERICAN SINOLOGY

EUROPEAN scholars justly reproach us for our lack of interest in and knowledge of the far east. We admit that our position in this regard is not what it should be, but we claim to have made a beginning, and that, too, on sound lines, and we feel that we should have the credit for this. At any rate, we are not prepared for the insolent criticism recently passed upon us by Professor J. J. M. de Groot, lately of Leiden, now professor of Chinese in the University of Berlin. Professor de Groot is a self-styled sinologue. We are quite content that that type of sinology is not represented in this country, and we trust never will be. The present state of mental stagnation and petrifaction in sinology, justly ridiculed by the world at large, owes much to such pseudo-scholars of the oil lamp who must be regarded as relics of a past age. Professor de Groot no doubt can read a Chinese sentence; but that would seem about all. He certainly understands little of the Chinese, and his lack of respect for China and things Chinese is so great as to place him quite beyond the pale of scientists.

Professor de Groot made his maiden speech in Germany at the July meeting of the Berlin Academy this year. His address is to be found on pages 607–612 of the *Sitzungsberichte der Königlich Preussischen Akademie der Wissenschaften* of this year. In the address occur these words:

> Sinology without a knowledge of Chinese thrives particularly well also in the United States. It is strong in the magazines, but abounds especially in the daily press. Information is imparted with the rapidity of the telegraph on the most complicated and profound secrets of the political, economic and social life of the Middle Kingdom—but the sources of this omniscience unfortunately, as a rule, are only from the bars of the foreign clubs in Shanghai, Tientsin and Hongkong.

The harshness and the undignified form of this assertion might be ignored did it not appear in such an important place as the Reports of the Royal Prussian Academy, a serious publication of one of the highest scientific institutions of Prussia. It is to be feared that this transplanted Dutch professor has little comprehension of what is really going on in the world; certainly he fails utterly to catch the spirit of modern journalism. What student of the Romance languages would cavil with his newspaper correspondent in Paris, who sends home each week his causerie of the goings on at the French capital, thus fulfilling a duty to his community? Or who demands of the Associated Press correspondent in Cairo or Constantinople, or even of the correspondent of the *London Times,* a knowledge of Arabic; or that the correspondent of the daily press in Bombay or Calcutta shall have a knowledge of Hindustani or be a Sanskrit scholar?

It has been my good fortune and my pleasure to become personally acquainted with many American, British, French and German correspondents in China. These men are confronted by an exceedingly difficult task. Without exception they do their best to perform this in accordance with the demand of the public and the present course of historical events. Our Associated Press for years has maintained in Peking an able, enthusiastic and well-trained man, who does most excellent work in educating the American public to a better appreciation of China. The work done by the Associated Press representative during the busy and stirring days of the revolution is excellent in the highest degree. He made no pretense of being a sinologue, but he worked day and night through interpreters to find out what was going on. He and his other fellow journalists, like the representative of the *Chicago Daily News* and the very able correspondent of the *New York Herald*—an old hand in the newspaper game—and the very able representative of the *New York Tribune,* all attempted and succeeded with eminent success in obtaining solid and reliable information from first-hand sources. In this work they were assisted by the Chinese Foreign Office and the whole body of Chinese officials who have for years made it a rule to supply the representatives of the press with news. Professor de Groot's bold statement that the information of the American press on China originates in clubs is a gross distortion of the facts and an utter violation of the truth. Professor de Groot's logic is at fault if he is unable to discriminate between this legitimate, honest, and most praiseworthy work of the newspaper correspondents and that which is expected of a sinologue or an ethnologist. Apparently, he is not able to understand that there are men in the world who see things at an angle different from that of the sinologue, and more is the pity that he should hold all in contempt that is not done according to his own one-sided way.

Professor de Groot's harsh criticism is all the more surprising in view of the fact that he was the guest of this country two years ago, having been invited by the Hartford Theological Seminary to lecture on the Chinese. It would seem that during this visit he should have gained some knowledge of the many-sided work done in America on Chinese research; but no evidence of this is to be found in his Berlin speech. This omission is so significant that we succumb to the temptation to look a little further behind the ill-disguised vanity of this professor who poses as the only infallible authority on matters Chinese. There is a further reason for our doing this: in replying to Professor de Groot's speech, the Secretary of the Berlin Academy intimated that the professor's writings contained much information and valuable suggestions for one desiring to understand the actual politics of the China of to-day. A significant example of this kind of practical politics may be found in Professor de Groot's "Religious System of China," which is little more than an ill-digested mass of Chinese quotations couched in bad English. In Volume III., page 1052, we find this gem:

Should European armies have occasion a second time to march on Peking, it will be worth their while to try whether the campaign can not be shortened and loss of life spared by military occupation of the burial grounds of the Imperial family. Indeed, should the Court receive an ultimatum that these tombs would be destroyed one after another by explosives, its belief in the efficacy of Fung-shui would be weakened, and the Court would implicitly submit to the foreigners' demands.

As a recommendation for a *modus operandi* to compel Chinese submission, this is, perhaps, without a parallel. Even the German government in the Boxer debacle of 1900 did not stoop to such depths. And yet, the paragraph just quoted is characteristic of the fiber of a man who professes to be a sinologue and shows neither a glimpse of sympathy with nor a particle of understanding of the Chinese people.

Professor de Groot's political zeal led him to accomplish a still greater triumph in the field of sinology. In 1904 he gave to the world, in two volumes, his "Sectarianism and Religious Persecution in China." In this he attempts to prove that the Chinese are the most intolerant people on earth, and he accomplishes his task by wilfully and maliciously ignoring the whole series of Imperial toleration edicts, of which the Jesuit missionaries are still proud. This sycophantic production was justly condemned by all thoughtful men; and, it is to be hoped, it will remain for all time a unique feat in the history of science that a university professor prostituted and humiliated his scholarship to political ends, dictated by an ephemeral fad of the time. No doubt many of our misconceptions of the Chinese are due to the distortions of missionaries, made with a view of proving their case, based on the necessity of their securing funds to carry on their work, but we are hardly prepared for such a perversion of facts at the hands of one who pretends to call himself a sinologue.

George A. Dorsey

RELATION OF PLASMA-GROWN TISSUE TO SENILITY

To the Editor of Science: The success of the method for prolonging the life of tissues grown in plasma, devised in the laboratory of Dr. Carrel, has led to such a widespread misconception of its significance, as evidenced by articles in medical and semi-popular scientific periodicals, that a note regarding it may not be out of place. It is needless to say that these extravagant claims are not based on Dr. Carrel's conclusions as published, but upon independent interpretations of the results of his experiments.

The mere statement of the conclusions generally reached by writers in the above mentioned periodicals is sufficient to indicate their character, to the biologist at least. It is first claimed that the cessation of cell activity of the tissue in the plasma after twenty days or so is due to the same conditions which produce senility. Then it is pointed out that the actual cause of the cessation in the plasma is the accumulation of waste products, therefore the proof is complete and the great discovery at last accomplished, that senility is the result of the accumulation of waste products in the cells. On the same grounds death of a human being through uremic poisoning would be considered as due to old age, and a man suffocated by drowning be a victim of senility. Obviously there is no evidence that the causes which stop the activity of the cells in the plasma are the same as those which produce senility. Senility is that cessation of activities that comes when external conditions are favorable.

Then, the fact that washing away the accumulated waste products at intervals leads to the reviving of the cell activities is considered to be a case of rejuvenescence and the conclusion drawn that since cell proliferation is more active at the end of eighty days than at the beginning, a method of obtaining immortality of the tissues has been discovered. Of course the normal length of life of the tissues used is several years, and indications of actual senility could not be expected before that time. The fact that the cells continue actively to proliferate has no significance as regards rejuvenescence, any more than the healing of a wound in the skin of an aged man by the normal processes of cell proliferation would indicate that his body was becoming juvenile. Cell proliferation in detached pieces of tissue is an expression of their inherent power of responding to form-regulation stimuli, which in living bodies governs the size and shape of the developing individual and even after maturity exhibits itself in regeneration of lost parts, production of new organs and in the processes of healing. The conditions in this respect of the cells of the detached piece, are evidently such as to call for the highest possible manifestation of cell proliferation, and this needs no other explanation.

The accumulation of waste products may be one of the results of the primary causes of senility, but even this much is not proved by these experiments.

H. M. Benedict

University of Cincinnati

SCIENTIFIC BOOKS

Die Muskeln des Stammes. By Paul Eisler. Jena, Gustav Fischer. 1912. Pp. 715, 106 figures, chiefly in colors.

This volume on the muscles of the head, neck, and trunk by Professor Paul Eisler, of Halle, constitutes a part of the extensive handbook of human anatomy now being edited by von Bardeleben with the cooperation of the leading anatomists of Germany. It is one of the most satisfactory of the series and illustrates how possible it is to make a real contribution in a field of work which for over three centuries has been as carefully cultivated as has gross human anatomy. The subject is considered from the purely morphological aspect, the mechanics of muscle action being left for treatment in other volumes of the series by Rudolph Fick. The only references to the physiological aspects of the subject relate to the theoretical developmental mechanics of the fascia, the tendons, and to a slight degree, of the muscles themselves. In the treatment of the various muscles of the head, neck and trunk admirable brief reviews are given of the various groups of muscles in each region. Then there follows an accurate description of each muscle of the group. The drawings to illustrate the various muscles are all from original sketches by the author, are all excellent, and in many cases are the best which have yet been made of the muscles treated. The topographical relations of the muscle are next considered and then the innervation. Eisler has made numerous personal contributions to this latter subject and gives a much fuller description of the innervation of the muscles treated than has hitherto been attempted. A brief description of the blood supply is next given and this is followed by an admirable summary of variations in structure, based not only on an extensive review of the literature, but also upon Eisler's own long experience in the dissecting room. Sometimes after the consideration of an individual muscle and always after the treatment of a group of muscles, the author gives an excellent summary of the comparative anatomy and the ontogenetic development of the muscle or muscle group. From "practical" considerations the author has, in the main, grouped the muscles according to the topographical relations in the adult, although he treats of the platysma with the superficial muscles of the head instead of with the muscles of the neck. This topographical grouping sometimes makes the treatment of the innervation, the comparative anatomy and the development of the muscles less satisfactory than if the grouping in all cases were along morphological lines. In an extensive, scientific reference handbook, it would seem to the reviewer better, for instance, to group the sterno-cleido-mastoid and the trapezius together, rather than to class the former with the "muscles of the neck" and the latter with the superficial muscles of the back. Some repetition would thus be avoided and the morphological relations of the muscles would be emphasized. In spite, however, of the traditional general classification of the muscles according to adult topographical relations, the author gives an exceptionally clear account of the morphological relations of the muscles and some excellent illustrations based on this point of view. The topographical treatment is an aid in the discussion of the fasciæ. After treating of the muscles of each part, as, for instance, of the head, the author gives an extensive description of the muscle fasciæ, the most extensive and satisfactory which has yet appeared. The fasciæ he justly considers not as independent organs, but rather as local thickenings or strengthenings of the general connective tissue framework, the thickness, structure and extent of which depends upon the mechanical stresses to which the part is subjected.

The author's style throughout is so clear, his summary of the literature is so satisfactory, his own contributions are so welcome and his point of view of the theoretical aspects of the subject is so suggestive even when one does not accept all the conclusions reached, that one can not but regret that the mechanics of muscle action have not to some extent been considered along with the morphological aspects of the subject. While this would have necessitated some repetition of the extensive field covered by Fick in the volume on special joint and muscle mechanics in the same "Handbook" it would, none the less, add not a little to the interest of the study of the detailed anatomy.

Not the least satisfactory part of the volume under review is the section devoted to the general aspects of myology. Here an admirable review is given of the more recent literature on the histology of striated muscle fibers, their physical and chemical characteristics and their development, and of the general structure of the voluntary muscles. In general opposing views of disputed points are fairly presented. The discussion of the connective tissue in relation to the muscles is especially good. Eisler, however, accepts O. Schultze's apparent demonstration of the continuity of the myofibrils with the connective tissue fibrils attached to the sarcolemma with less reserve than would seem to the reviewer justified. The general, like the special, treatment of the muscle fascia is a contribution of importance.

Taking the volume as a whole, it should prove of much value not only to those interested in scientific human anatomy, but also to the zoologist interested in comparative anatomy.

C. R. BARDEEN

UNIVERSITY OF WISCONSIN

The Physiology of Protein Metabolism. By E. P. CATHCART, Ph.D., D.Sc. Monographs on Biochemistry. Longmans, Green and Co. 1912. Pp. viii + 142. Price $1.25.

Like the other monographs of this series, this book is from the pen of an ardent investigator in the field of which he writes. To those who derive their knowledge of the subject of nutrition from text-books, the present volume will offer numerous surprises. In many places the treatment consists in the exposition of the various points of view of specific problems relating to protein metabolism, which rest upon experimental data, and does not therefore furnish a complete and harmonious story. This style of treatment is most commendable, for with no other attitude could the author give an adequate picture of the state of our knowledge of this complex subject.

The book surveys the literature up to the end of the year 1910, and appeared at a rather unfortunate time, for never in the history of protein metabolism investigations, have such enlightening studies been published during any like period as during 1911 and the first half of 1912. The admirable work of Osborne and Mendel on the physiological rôle of the individual proteins, and of Folin and Denis on the fate of the products of protein digestion after absorption, came too late for inclusion in this edition.

The author has succeeded admirably in adhering closely to the physiological aspects of protein metabolism, a difficult task, when a vast amount of experimental data relating to the chemical aspects of the same subject is now available. This attitude is a desirable one at the present time, when there is a strong tendency on the part of text-book writers and dietitians to assume that an adequate supply of "building stones" in the diet is all that is essential to insure physiological well-being in the animal. The author has done a good service to his fellow workers in producing a treatise which will assist in creating new attitudes toward the problems concerned, and to the great number of teachers who follow the original literature to but a slight degree or not at all, in presenting in so clear a form, the experimental lines of inquiry directed toward the solution of problems of protein nutrition, and the different points of view to which these have led.

E. V. McCollum
University of Wisconsin

Scientific Results of the Voyage of S. Y. "Scotia" during the Years 1902–1904. Vol. III., Botany. Edinburgh, The Scottish Oceanographical Laboratory. 1912. 4to. Pp. x + 153, 12 pl., 1 chart.

Nearly simultaneously with the publication of this volume, now dedicated to his memory, Sir Joseph Hooker, the dean of botanists and the author of the "Flora Antarctica," passed from his earthly labors. The botanical results of the Scottish National Antarctic Expedition are derived principally from two summer visits to the South Orkneys and a winter spent at Laurie Island in Scotia Bay; a hasty visit to Gough Island; extensive collections of the algæ of Weddell Sea; notes on the botany of Ascension Island; and incidental collections made on the outward and homeward voyages. The report on the phytoplankton will be issued later.

The present volume opens with an introduction by Dr. Rudmose Brown on the problems of Antarctic plant life. Recent explorations have shown that the South Polar flora is in some respects richer than has been supposed, though its chief interest is derived from its relations to the problems of geographical distribution and the origin of the Antarctic flora.

With the exception of a doubtful fossil of conifera, possibly of Devonian age, found in Victoria Land, the known Antarctic fossil plants are those obtained by Otto Nordenskjöld from Hope Bay, Graham Land, ferns, cycads and conifers indicating a warm moist climate and abundant vegetation in Jurassic times. The fossil *Araucaria, Fagus,* etc., found at Seymour Island by the same expedition indicate the extension of somewhat similar conditions into the Tertiary.

The most striking feature of the Antarctic flora is its poverty compared with that of the Arctic. Spitsbergen in summer in 79° north latitude supports a hundred species of flowering plants, while at the South Orkneys in only 61° south there is not a single species. In Grant Land, in 81° and 82° north latitude, Peary collected 57 mosses and 7 hepatics, more than are known from the whole Antarctic region south of latitude 60°.

The explanation lies chiefly in the fact that while the Arctic summer mean temperature is well above the freezing point, that of the Antarctic is practically always below it. Another factor is adverse to the establishment of plants on the few snowless patches of Antarctic land, namely, the presence of myriads of penguins, which cover these areas with their guano and trample them into mud whenever the temperature is above the freezing point. The few sheltered spaces where mosses occur are poorly suited to flowering plants. Yet that their introduction is possible by natural causes is indicated by the discovery of pollen grains of the South American *Podocarpus* in the snow of South Orkney by Dr. Fritsch.

There are only two phanerogams known from the Antarctic, *Descampsia* and *Colobanthus,* which are the most southerly flowering plants known. There are no ferns, and mosses form the major terrestrial plant population, 52 species being known, of which 24 are endemic. The lichens are conspicuous, but few in species. The algæ, especially the unicellular kinds are abundant.

All the known facts, according to Dr. Brown, point to a Fuegian origin for the flora. A greater former extension of glaciation, which is well proved, is regarded as inimical to the descent of any part of the present flora from that of Tertiary times.

Beside the chapters on the botany of the South Orkneys, Gough Island and Ascension Island by Dr. Brown, Cardot contributes a general review of the mosses; Gepp, Holmes, Foslie and Fritsch treat of the fresh-water and marine algæ; and Harvey Pirie contributes notes on Antarctic bacteriology. The volume concludes with a useful bibliography of Antarctic botanical publications.

WM. H. DALL

A Text-book of Physics. Edited by A. WILMER DUFF. Third Edition. P. Blakiston's Son & Co. 1912.

The third edition of Duff's "Physics" is a great improvement typographically over the previous editions, and is consequently so changed that if it were not for the uniform binding of the three editions it would appear at first glance to be an entirely new book. Practically all the cuts have been made over from new drawings, with a noticeable increase in clearness and uniformity of size, or have been replaced by other and better ones. This, with the choice of better type, makes the reading much easier. As in the previous editions, the main subdivisions are by different men, but the order has been changed, "Wave Motion" coming after "Mechanics," and "Sound and Light" after "Electricity"; and there seems to be more unity of treatment in the whole and a natural connection between the parts which saves them from appearing as disjointed treatises. The text of the "Mechanics," by A. W. Duff, is practically unchanged from the previous edition, and the same may be said of "Wave Motion," by E. P. Lewis, and "Sound," by Wm. Hallock. "Conduction of Electricity through Gases and Radioactivity," by R. K. McClung, has a few changes and additions noticing some recent developments, but is otherwise unchanged. "Light," by E. P. Lewis, has been reduced in amount and improved by being partly rewritten and rearranged (though it previously possessed considerable merit). The portions on Heat and Electricity and Magnetism are entirely new. The part on Heat is by C. E. Mendenhall, of the University of Wisconsin, replacing that by K. E. Guthe in the other editions. The arrangement of the subject matter seems to be more logical and more briefly stated, and there is an improvement in the choice of illustrations, but in places there is less clearness of statement and treatment than in the previous edition. Nowhere is the improvement in the drawings more noticeable than in the case of "Electricity and Magnetism," by A. P. Carman, of the University of Illinois, which replaces that by A. W. Goodspeed in the previous editions and comprises also the former section by Professor Carman on Electromagnetic Induction, thus securing a desirable unity of treatment in this subject. Taken as a whole the parts of the book are remarkably well welded together, and, having as authors specialists in the different departments, it should rank among the best college texts of the day.

LOUIS A. PARSONS

Maschinen und Apparate der Starkstromtechnik (Machines and Apparatus for Heavy Currents). By GUSTAVE M. MEYER. Published by B. G. Teubner, of Leipzig and Berlin. 1912.

So rapid has been the development of machines and apparatus used in connection with the many applications of electricity to power purposes that it is well-nigh impossible for any one to follow carefully the progress in inventions and research. Electrical engineers have desired some book which would give in concise form descriptions of electrical machinery and numerous auxiliary devices used in conjunction with them. Few of us have time or opportunity to become thoroughly familiar with more than one specialty.

Furthermore, preliminary work in universities requires a book which describes briefly the most important features of various forms of electrical apparatus. There are at present electrical treatises which specialize and at the same time emphasize theory more than they do practical operation. Other books are practically compilations of extracts from patent specifications and catalogues, many of them describing obsolete or impracticable apparatus; such works are usually lacking in critical comment. Appreciating the need for this type of book, Mr. Meyer has brought forth in his "Maschinen und Apparate der Starkstromtechnik" a book which would meet the existing demands. Believing that books on electric lighting and railroads are now sufficiently numerous, the author has omitted these phases of the subject. On the other hand, he has endeavored to give such information as the consulting engineer and student desire, relative to high-voltage apparatus and their applications, as well as descriptions of turbo-generators and alternating current commutator motors.

The book is divided into two principal parts, viz: Direct Current and Alternating Current. The first part the author devotes to direct current measurement, control and storage of electrical energy; direct-current generators and motors, their uses, specific applications, and auxiliary apparatus. The second part, comprising about two thirds of the book, deals with measurement and control of alternating currents; construction and performance of alternating current generators and induction motors; alternating current transformers; distribution of electrical energy by means of alternating currents; and several kinds of attendant or auxiliary apparatus used in conjunction with alternating current.

The author has devoted considerable attention to the characteristics of alternating current machinery such as turbo-generators, synchronous generators and motors, and induction motors, as well as to speed control by means of commutator motors, these including the systems of Scherbius and Kraemer. Space is also given to various forms of alternating current commutator motors, such as the repulsion, the series and compensated types, with which latter the names of Latour, Winter and Eichberg are associated.

It could hardly be expected that a book covering so great a field could be without errors. For example, a means is given for determining the regulation of A.C. generators from the no-load saturation and short-circuit characteristics, and while armature reaction, and armature self-inductance and resistance are considered, the effect of incremental pole leakage with load has been entirely neglected. It is well known that when the poles are saturated, the change in pole leakage with load at fractional power factors has a not inconsiderable influence upon the regulation. More emphasis than is necessary is placed upon the influence of the resistance of the stator at zero power factor; this is generally negligible when the current lags behind the electromotive force by 90 electrical degrees.

The book has a remarkably small amount of mathematics and hence it should be easy for any one to follow who is studying along these lines or attempting to familiarize himself in a general way with a part of the subject differing from his specialty. The text contains 590 pages, including 772 illustrations pertaining, so far as possible, to modern machines, both European and American. It would be impossible, however, for a book of this character to be up-to-date some years hence, as electrical apparatus becomes obsolete in a comparatively short period. The author has wherever possible given his authority, so that any one desiring further information can refer to same for a more complete understanding of the subject.

Carl J. Fechheimer

October 29, 1912

BOTANICAL NOTES

MYCOLOGICAL NOTES

As usual the new Report of the State Botanist[1] is very largely given over to the classification and description of the larger fungi. Nine colored plates, mostly of the edible fungi, accompany the report.

C. N. Jensen's "Fungous Flora of the Soil"[2] brings together what is known as to the fungi ordinarily to be found in the soil. After a general discussion of the subject accompanied by the citation of many publications, the fungi are arranged and described in systematic sequence. In the latter part there are many helpful figures in the text.

Professors L. R. Jones, N. J. Giddings and B. F. Lutman publish[3] the results of their investigations of the potato fungus *Phytophthora infestans.* It is a summary of the present state of our knowledge of this parasitic fungus, and includes a long list of the literature of the subject (105 titles), and ten plates.

Miss Frances Dorrance (Dorranceton, Pa.) has made an English translation of Part XIII. of Dr. Oscar Brefeld's "Investigations in the General Field of Mycology." Only 150 copies were printed and these were privately distributed. The work appears to be carefully done, and since this part relates to Smut Fungi, the translation should have a wide sale. ($1.75.)

SYSTEMATIC NOTES

"The North American Species of Nymphaea" is the title of a paper by G. S. Miller and P. C. Standley, and is issued as one of the Contributions from the U. S. National Herbarium (Vol. 16, Pt. 3). The genus here monographed is what many of us learned as *Nuphar,* and includes the Yellow Water-lilies of the country. After a long study of these plants the authors are able to recognize nineteen species for North America, five of which are quite widely distributed, viz.: *N. microphylla* Pers. (eastern Canada, New York to New Jersey), *N. rubrodisca* (Morong) Greene (Canada, New York to New Jersey), *N. americana* (Prov.) M. & S. (eastern Canada to British Columbia, south to Nebraska, Ohio and New Jersey), *N. advena* Ait. (New York and New Jersey to Wisconsin, Nebraska, Kansas, Kentucky and North Carolina), *N. polysepala* (Engl.) Greene (Alaska to California, eastward to Colorado and South Dakota). The illustrations and maps showing distribution of species add to the value of the paper.

Dr. William Trelease essays a classification of the Black Oaks in a recent paper in the *American Philosophical Society* (Vol. LI., 1912), accompanying the paper with four plates of buds and acorns.

[1] Bull. 157, N. Y. State Museum.

[2] Bull. 315, Cornell University Expt. Station.

[3] Bull. 245, Bureau of Plant Industry, U. S. Dept. Agric.

THE RETURN OF THE NATIVE FLORA

Recently Professor M. R. Gilmore, of Lincoln, called my attention to an observation which he had made upon the return of the native flora on an abandoned tree plantation on the high Nebraska plains. At my request he has given the particulars in the following summary statement:

It is a problem of much interest to the writer hereof to observe the repossession by the native flora of areas from which it has been dispossessed. Among the places of which particular note has been made was an abandoned tree claim in Sheridan County, Nebraska, in the topographic region known as the High Plains, popularly called the Short-grass Country. This observation was made in the first week of August, 1912, on a tract of land about six miles northwest of Rushville, Nebraska, which had been entered under the Timber Claim Act of Congress. The number of acres required by law to be planted with trees had been broken out (plowed) and set in elm and ash trees, and after that nothing more had been done to the land, so that for about twenty years the original flora has been gradually repossessing the ground. I estimated that about 5 per cent. to 10 per cent. of the trees were still struggling to live, being in no case more than ten feet tall, and in most cases not more than two and a half feet tall and many less than that. Following I give a list of twenty-five species by name which I found to be stably reestablished, besides which I found half a dozen or more others which I did not identify. Those identified were: *Bulbilis dactyloides* (Nutt.) Raf., *Stipa comata* Trin. and Rupr., *Malvastrum coc-*

cineum (Pursh.) A. Gray, *Pentstemon* sp., *Artemisia frigida* Willd., *Brauneria pallida* (Nutt.) Britton, *Grindelia squarrosa* (Pursh.) Britton and Rusby, *Astragalus* sp., *Psoralea floribunda* Nutt., *Erigeron* sp., *Kuhnistera purpurea* (Vent.) MacM., *Lithospermum* sp., *Ratibida columnaris* (Sims.) D. Don., *Antennaria campestris* Rydb., *Verbena hastata* L., *Verbena bracteosa* Michx., *Helianthus scaberrimus* Ell., *Carduus altissimus* L., *Bœbera papposa* (Vent.) Rydb., *Solidago* (two species, unidentified), *Aster* sp., *Solanum carolinense* L., *Rosa arkansana* Porter.

Charles E. Bessey
The University of Nebraska

PALEOLITHIC MODELERS IN CLAY

The discovery, on July 20 last, by Count Bégouen and his two sons, of a new French cavern with paleolithic mural decorations has already been noted in Science.[1] This cavern, called Tuc d'Audoubert, situated near St. Girons (Ariège), was visited by the writer five days after its discovery, but did not even then yield up all its secrets. We noted certain small openings leading apparently to other galleries then closed against us by deposits of stalactite and stalagmite. At Geneva in September Count Bégouen informed me that he had entered one of these and found additional parietal engravings. In a communication to me dated October 23, he announces that at the end of still another long and difficult upper gallery, reached only after breaking away stalagmite pillars, he and his sons have found two clay statuettes intact, representing the *Bison*, male and female 63 and 61 centimeters long respectively. In an antechamber as well as the upper gallery these Magdalenian artists also left their footprints on the soil superimposed on footprints of the cave bear, whose skeletal remains were strewn upon the cavern floor. All the canines were missing, however, from the jaws, having evidently been removed as Magdalenian trophies. A perforated tooth (Bovidæ) and several flint implements were found on the cavern floor.

The artist races inhabiting southern Europe in later paleolithic times were sculptors of real merit. They worked laboriously in stone, ivory, bone, and horn with excellent results and without the use of metal tools. That paleolithic man had realized any of the possibilities of clay as a plastic medium has always been denied. Absence or presence of pottery has been universally invoked as a chief factor in distinguishing paleolithic and neolithic horizons. The clay figures found by Count Bégouen are unbaked, to be sure; but they prove that only the accident of firing stood between the Magdalenian races and one of the great inventions of all time. These figures were never wholly separated from the matrix out of which they were fashioned. They seem to stand out of a clay talus slope that flanks a fallen rock, the male following the female. For the present no attempt will be made to remove them from this shrine.

George Grant MacCurdy
Yale University

[1] August 30, 1912, p. 269.

THE PROGRESS OF MOUNT ROSE OBSERVATORY, 1906–1912

Mount Rose Observatory, although the youngest of the meteorological observatories in America, has an environment so unique that its staff has not only obtained a series of problems of prime importance to pure science and to agriculture but has also found such abundant material that rapid progress has been possible in their solution. A brief statement of plans and progress at this observatory may, therefore, not be without interest to workers in the meteorological field.

Mount Rose is a peak of the Sierra Nevada Mountains at the western edge of the Great Plateau. The observatory on the summit, which is 3,292 meters above sea level, at present is the highest meteorological station in the United States, and was established privately for the purpose of ascertaining the winter minimum temperatures at the summit of the Sierra. Later it was made a department of the University of Nevada and the Agricultural Experiment Station and through these institutions has received financial aid from the state and from the Adams Fund of the Office of Experiment Stations.

The observatory is very favorably situated for the study of mountain and desert meteorology, the relation of topography to the occurrence of frost, and the influence of mountains and forests upon the conservation of snow. Most of the instruments and methods employed in the work of the observatory have been devised by its staff.

In the study of mountain meteorology, the observatory has the advantage of occupying a virgin field, and thus being placed in a position to supplement the work done at Mount Royal by McGill Observatory, in the Appalachians by the Mount Washington, Blue Hill and Mount Weather observatories, in the Rocky Mountains at Pikes Peak, and in the Coast Range at Mount Tamalpais. Mount Rose Observatory is unlike its predecessors in that no observer is maintained continuously on the summit, and most of the instruments in use have been constructed to work without attention for long periods of time.

After much experimenting there has been devised a meteorograph that is impervious to the wild storms that rage in winter on mountain summits, and a shelter has been constructed for it that clears itself of accumulated snow. Six elements are recorded, viz.: pressure, temperature, direction and velocity of the wind, humidity and sunshine. The records are made upon a band of metric cross-section paper 270 mm. wide, which moves 2.5 mm. an hour or 1.8 meters a month. The recording mechanisms are adjusted to the ruling of the paper so that one millimeter equals one degree of temperature, two per cent. relative humidity, and one millimeter of atmospheric pressure. The meteorograph is actuated by springs placed within a motor drum. Two auxiliary drums serve to hold and receive the paper as it passes over the motor drum against which the recording pens rest. This instrument will run for at least two months with one winding of the clock. The resetting of the meteorograph is readily accomplished by disconnecting it from the shelter and removing it to the observatory building.

Some defects that occasionally cause failure to obtain satisfactory records have been partially corrected in the following manner: To prevent slipping of the record sheet, a double series of tiny needle points has been fitted into the motor drum with v-edged pressure wheels running astride of them to force the sheet close to the drum. To detect possible inaccuracy in the motor clock, a standard pendulum clock actuated by weights has been installed in the observatory building and connected by electric cable with a pen in the meteorograph to record the twelve o'clock hours each day. Excessive vibration has been eliminated in the shelter by the use of heavy braces and rock on the sills.

Mechanical registration is employed in all elements except sunshine, and the performance of electrical devices tried thus far has been so unsatisfactory that probably a mechanical sunshine recorder will eventually replace the electrical one. Dry batteries have been made worthless by freezing, and the efficiency of wet batteries is so reduced in cold weather that it seems improbable that any system depending on electricity will be successful.

The great problem is the prevention of the formation of fins of ice and frost upon the instruments. The sunshine recorder has been safeguarded by a heavy bell-jar. The tail of the anemograph vane has been made of wood and the arrow so shortened that the vane will swing into the eye of the wind irrespective of ice accumulations on the arrow. The masts have been enlarged in size and made self-sustaining without guy rods, which invite the formation of festoons of heavy ice with consequent wrecking of the masts. The only serious problem of equipment still unsolved is the protection of the cups of the anemometer from ice. This can be accomplished in part by removing the portion of the supporting arms that pass through the cups and thus expedite the dropping of the accumulated slugs when the cups are warmed by the returning sun. However, there may be some material, such as vulcanized rubber or papier mâché, of which cups can be made, which will be less attractive to frost and ice than the metals used at present. The wind record has usually been complete between the months of May and October.

This meteorograph on the summit (elev. 3,292 meters) is flanked by two similar instruments, one on the west at Truckee (elev. 1,798 meters), thirty miles distant, and the other on the east at Fallon (elev. 1,208 meters), fifty miles distant, thus affording a base line eighty miles long and an apex approximately one mile high. Kite flights have been inaugurated to determine the meteorological error of the summit station. By means of this vertical triangle of stations, data are now being actively gathered on the changing phases of passing storms, and their possible relation to the weather of the valleys beneath.

A station with instruments of great precision is being established on the university campus. The study of the movements of air currents will be made by pilot balloons, for the plateau is too sparsely settled to permit the use of ballons-sondes. A share will also be taken in the international kite flights.

In the realm of applied science, the forecasting of frost from mountain tops is one of the two main problems through which it is desired to make the observatory of practical service. This problem is still in the stages of data-gathering; however, some relationship is evident between the passing of storms and the occurrence of frost.

This problem has given rise to two others: the relation of topography to the occurrence of frost, and a temperature survey of the agricultural lands of the state of Nevada. For the study of the first problem, two stations with delicate apparatus for detecting minute changes in humidity, temperature and air movements are under preparation to be placed near the surface on typical slopes in conjunction with a free air station at the university.

The temperature survey has now been in progress for two seasons. The purpose of the survey is the delimiting of large areas suitable for fruit raising under all forms of economic frost prevention, and the further division of these areas into thermal belts according to the following classification:

(*a*) Belts where the minimum temperature never falls below 28° F. and fruit raising would be highly profitable.

(*b*) Belts where the minimum temperature is between 24° and 27° and frost can be combated at a reasonable expense.

(*c*) Belts where the temperature falls between 18° and 23° and fruit raising as an industry would not be profitable.

In belts where temperatures of 17° or lower are encountered fruit raising is not advisable.

Eighteen stations equipped with thermographs and standard thermometers are now being employed in the work. The number may finally be increased to twenty-five. These stations are distributed at strategic points from the highest land under irrigation canals to the lowest parts of the valley. It is planned to obtain continuous records at each station for three years before removing the station to a new point. The survey at present covers the basin of the Truckee River, on which is situated the metropolis of the state. Owing to the hearty cooperation of ranchers, who act as voluntary observers, the expense of the maintenance of the survey is slight.

In the spring of 1911, when frosts were heavy and frequent, the observatory staff, in conjunction with others, demonstrated the feasibility of orchard heating even under strenuous conditions, with the result that where only one farm corporation was heating its orchard that season, the present year between fifteen and twenty owners of fruit trees were engaged in the work. To give the orchardists assurance of support in their effort, a night telephone service was maintained for emergency frost-warning and two automatic frost alarms were installed. To further aid the isolated orchardists in making their own forecasts of frost, an analysis of the fluctuation of temperature under semi-arid conditions is now being made. To this will soon be added the determination of the quantitative effect of cloudiness and wind on the retardation of falling temperatures.

The second problem to which special attention is being devoted is the influence of mountains and forests on the conservation of snow.

This problem is of vital importance to irrigationists and power companies wherever streams are fed by snow.

The data for the study of this problem are very abundant. Mount Rose is situated between the heavily forested main chain of the Sierra Nevada and the scantily forested ranges of the semi-arid Great Basin, and forms the natural headquarters for the study of both. On the flanks of Mount Rose and its subjacent range are also wide areas long since deforested and now in various stages of reforestation, while the apex of the mountain furnishes abundant opportunity for studying the snow where it falls deepest and longest. The observatory building on the summit has now been supplemented by a headquarters camp, made of sandbags, at Contact Pass (elev. 2,744 meters) and another camp at the base of the mountain. By means of this chain of stations, measurements of snow depth and density, the evaporation of snow, and temperatures within the snow have been conducted on the mountain for limited periods.

Adjacent to Mount Rose is the basin of Lake Tahoe, where a coast line seventy miles long has furnished ready access throughout the winter, by means of motor boat and explorer's camp, to forests of various types and densities, and to all the typical slopes and elevations found in the Sierra Nevada.

The study of the conservation of snow was begun with camera in the winter of 1906, and in the spring of 1909 there was designed a snow sampler by means of which cores can be obtained from snow-fields of all depths and densities, the water content of the sample being determined by weight. Soon after, a spring balance was devised that would indicate without any computation the equivalent water in the sample irrespective of variation in the length or weight of sampler used. By means of these instruments thousands of measurements have been made, and the quantitative value of forested areas and their superiority over unforested was early established.

The minute investigation of the various phases of the problem has proceeded more slowly, but considerable progress has now been made toward their solution. The general principle underlying the conservation of snow is that of protection against evaporation and melting by wind and sun. Snow lies longest where it falls deepest. Cliffs and lee slopes are large gatherers of snow. Yet wherever forests crown such slopes the capacity of these slopes to gather and conserve snow is increased. In wind-swept regions, timber screens have a snow-gathering capacity varying according to their height and imperviousness to the wind. They also, by checking the wind, reduce the evaporation of snow, which under the influence of a wind movement of 33 miles per hour, despite the fact that the snow was frozen, has reached in a single night the total of .10 in. moisture content, or one one-hundred-twentieth of the total snow on the ground.

The action of unbroken forests upon the snow is unlike that of timber screens, particularly on the lower slopes where the wind is less violent. These forests catch the falling snow directly in proportion to their openness, but conserve it, after it has fallen, directly in proportion to their density. This phenomenon is due to the crowns of the trees, which catch the falling snow and expose it to rapid evaporation in the open air, but likewise shut out the sun and wind from the snow that has succeeded in passing through the forest crowns to the ground.

The most efficient forest, therefore, from the point of view of conservation is the one that conserves the largest amount of snow to the latest possible time in the spring. This has been found by measurement to be the forest with a maximum number of glades, which serve as storage pits into which the snow can readily fall but the wind and the sun can not easily follow. One such forest was found to have conserved at the close of the season of melting three and one half times as much snow as a very dense forest adjacent to it.

The most efficient type of forest found at levels below 8,000 feet is the fir, whose foliage is much more impervious to the rays of the sun than that of the cedar or pine. At 8,000 feet or higher, the mountain hemlock is most efficient, for not only is its foliage dense, but its tapering spire-like crown offers but little resistance to falling snow.

In the light of the above facts forests may be too dense as well as too thin for the maximum conservation of snow. The ideal forest seems to be one filled with glades whose area bears such proportion to the height of the trees that the wind and the sun can not reach the bottom. These glades can be produced by the forester by judicious pruning and cutting as well as by proper planting. However, the mountain hemlock requires little or no pruning to attain its maximum efficiency.

In the field of hydrology, surveys of snow on the Mount Rose and Lake Tahoe watersheds have been made since the beginning of 1910 to indicate to ranchers and power companies in the basin below the amount of water to expect during the season, and thereby to assure the better control of the reservoirs. This work will be extended to include a study of the behavior of snow on typical slopes during rising temperature and wind with the view of forecasting the probability and extent of floods. For the purpose of offering foresters in the national forests and others the advantage of the investigations in snow a course is now planned at the University of Nevada on the relation of mountains and forests to the conservation of snow, including the improvement of the storage of snow by the planting and pruning of forests to assure the control of stream flow and the increase of irrigation and power resources. Other courses in general meteorology have already been provided.

The staff of the observatory consists of Professor S. P. Fergusson, formerly first assistant at Blue Hill Observatory, who is associate meteorologist, Mr. Arthur L. Smith, observer in Lake Tahoe Basin, and the writer, who is in charge.

Besides annual reports and news bulletins, the more important recent publications are Experiment Station Bulletin No. 79, "The Avoidance and Prevention of Frost in the Fruit Belts of Nevada," and an article on the "Conservation of Snow: Its Dependence on Forests and Mountains," in *Scientific American Supplement*, Vol. LXXIV, No. 1914 (September 7, 1912), pp. 152–55. A bulletin containing an elaborate presentation of the relation of mountains and forests to the conservation of snow is now being prepared.

J. E. Church, Jr.

Reno, Nevada

SPECIAL ARTICLES

THE CULTIVATION OF AN ECTOPARASITIC NEMATODE OF A GUINEA-PIG ON BACTERIOLOGIC MEDIA[1]

On May 6, 1912, while examining a guinea-pig which had died of an unknown cause, it was noted that the skin around and just anterior to the external genitalia was excoriated and covered by a yellowish, cheesy exudate. On examining the exudate under the low power, a large number of actively motile embryonic and adult nematodes were found. On May 7 a second guinea-pig exhibiting a similar, but less extensive, lesion and harboring the same ectoparasitic nematodes was discovered. Lately, a third guinea-pig was encountered, harboring the same nematode not only around the external genitalia, but also on the normal skin of the abdomen and thorax. Careful examination of these and of a number of other guinea-pigs has failed to reveal the presence of the nematode in the gastro-intestinal tract or in any of the internal organs.

A little of the caseous material from the first two guinea-pigs was inoculated onto moist earth and slants of Musgrave's amœba agar and kept at room temperature (about 24° C.). In a few days, a large number of actively motile nematodes were found in these cultures. The amœba agar cultures have, since then, been carried through five subcultures and the worms have also been successfully carried through several subcultures on slants of plain agar and ascites agar. The plain agar and the amœba agar have proved to be the best media, because the accompanying bacterial growth is relatively limited in amount. In several of the above subcultures

[1] A preliminary note, from the laboratory of the Cincinnati Hospital.

the worm has been seen to pass through two complete cycles of development. In one subculture the worms have multiplied and remained actively viable for 23 days, without transplantation.

A striking peculiarity of the growth on the agar cultures is the tendency of the worms to crawl up on the side of the test-tube opposite the slant and there clump themselves into macroscopic groups. Under the low power, these groups are seen to consist of an immense number of very actively motile nematodes in all stages of development.

As yet, we have not determined the exact species of this nematode, but in all probability it belongs to the Anguillulidæ.

N. B.—Since the above was written we have learned from Professor Henry B. Ward of similar cultivation experiments carried out in his laboratory by H. Metcalf.[2]

Wade W. Oliver

RECENTLY PROPOSED SPECIES OF THE GENUS DICERATHERIUM

Since the opening of the Agate Spring fossil quarries in the Miocene formation of Sioux County, Nebraska, by the Carnegie Museum field parties some eight or nine years ago, there has been great activity by many institutions and private parties in this general field. As a consequence much material of fossil remains has been gathered, of which the greater portion, especially in the Agate Spring fossil quarries, consists of bones pertaining to the Rhinocerotidæ.

Pending the publication of a more extended work on the American Diceratheres, now in progress, the purpose of this note is to avoid the recurrence of certain interpretations on the part of students interested in the question of deciduous and permanent teeth.

In recent years there have been a number of new species described of Professor Marsh's genus *Diceratherium* which will be duly considered later. In 1908 Professor Loomis, of

[2] "Cultural Studies of a Nematode Associated with Plant Decay," *Trans. Amer. Microscop. Soc.*, 1903, 24, p. 89.

Amherst, proposed a number of new forms.[1] One of these (*D. aberrans*, p. 59) is established on a second deciduous cheek-tooth of the left side. Very recently Mr. Harold J. Cook has unfortunately used deciduous teeth as a type of still an additional species *D. loomisi*.[2] The type of this latest species consists of a portion of the right upper maxilla, containing not P^4, M^1 and M^2, as Cook states, but the second, the third and the fourth deciduous cheek-teeth. This is abundantly demonstrated in the large collection from the Agate Spring fossil quarries now under study in the Carnegie Museum.

In this connection it is well to state that the formation of the permanent premolars 2, 3, 4 of *Diceratherium* starts comparatively late. I have excavated maxillæ (Nos. 2464, 2476, Carnegie Museum) of young specimens and often find that while the deciduous 2, 3 and 4 are considerably worn the germ of P^2, which is located immediately above the roots of D^2, is only very slightly and more often not at all indicated. At the same time P^1, which is erupted in an early stage, is on an even grinding plane with the milk teeth and has received considerable wear; more than half of the grinding surface of M^1 appears through the alveolar border, while M^2 is represented by a large excavation immediately back of M^1. In comparing Mr. Cook's figures (*l. c.*, p. 31) I judge that he has described a young specimen of *D. cooki* in the stage of development described above. In a later stage of development (specimen No. 1848) the formation of the permanent premolars is well advanced, especially in 2 and 3. M^1 is completely erupted, M^2 appears in a large triangular opening of the alveolar border, while M^3 is represented by a similar excavation to that of Nos. 2464 and 2476 above described. Thus it is repeatedly demonstrated that a large collection of a genus or species is extremely useful as a safeguard against the misinterpretations of which the systematists are surrounded.

O. A. Peterson

[1] *American Journal of Science*, Vol. XXVI., pp. 51–64, 1908.

[2] Nebraska Geological Survey, Vol. VII., Part 4, pp. 29–32.

SOCIETIES AND ACADEMIES

THE ACADEMY OF SCIENCE OF ST. LOUIS

The first meeting of the season was held at the Academy Building on Monday evening, October 21, 1912; President Engler in the chair.

Dr. G. O. James, of Washington University, addressed the academy "On the Contingence of the Physical Theory and the Problem of the Geologic Past."

After reviewing the theories of Helmholtz, Mach and Enriques on the principle of causality, Dr. James stated that as far as descriptive representation of the present is concerned, it makes no difference whether or not we admit that pushing the precision of measurement further and further we shall ultimately come to a point where there ceases to be accord between observation and theory, and beyond which it can not be again established.

The postulate of causality builds the program according to which we must envisage the geologic past and prescribes the confines within which expectation places the future. Without it neither would exist for us. In answer to whether a past or future created in accordance with the postulate of causality possesses reality, it was pointed out that the older point of view, which regarded empirical verification as a proof of reality, which nevertheless did not cease to exist even when all connection between the external world and its representation was broken, has given way to a modern conception of reality of which invariance is the criterion, but regards this invariance as relative and approximate.

Dr. James also read an appreciation of the life and work of Jules Henri Poincaré, who died July 17.

The academy met on Monday evening, November 4, 1912; President Engler in the chair.

Professor Nipher, of Washington University, gave a verbal account of work supplemental to that published in his last paper.[1] This work has reference to the longitudinal creeping of a copper wire through which spark discharges are passed.

In his latest work the wire is laid upon a strip of plate glass having a length of 71 cm.

The wire extends several centimeters beyond the glass and the ends drop downwards about 8 or 10 centimeters. The discharges are sent into the side of the wire from above, and just outside of the glass support. Small brass cylinders are placed between the wire and glass at the ends in order to eliminate frictional contact at the edge of the glass. The main portion of the wire rests upon the glass. A condenser formed of tinfoil and sheets of glass having the dimensions 26×26 inches was used. The total area of tinfoil in the condenser was 2×15 square feet.

The recent results were obtained when one of the discharge terminals was grounded. When the positive terminal is grounded a compression wave is sent surging through the wire, and the wire is driven in the direction of the corpuscular displacement thus impressed upon the nebulous corpuscular column within the wire.

When the negative terminal is grounded, a rarefaction wave is sent through the wire in the opposite direction. The displacement is in the same direction as before. The air-gap between the positive terminal and the wire is then first converted into a drainage or conduction channel, and the discharge from the wire is drained into it. The wire now creeps in a direction opposite to that of the corpuscular displacement. In one case an aluminum wire was made to creep over a distance of 18 cm. by the passage of about 1,200 sparks.

When neither terminal is grounded the wire also creeps in the same direction as when the negative terminal is grounded. The surging effect of the compression wave is then eliminated. This is the condition discussed in Professor Nipher's paper forming No. 3 of Vol. XXI. of *The Transactions* of the academy, to which reference is made in Science, August 2, p. 153.

When a short wire 4 or 5 cm. in length is placed upon the glass plate, two or three cm. from the creeping wire, it creeps in the direction in which it is urged by the surging wave which is induced in it. The direction is the same whether the wave in the primary wire is one of compression or of rarefaction, or whether both are simultaneously imposed. The short wire is placed opposite the middle of the primary wire.

All of these creeping effects are reversed in direction, when the direction of discharge through the main wire is reversed.

Mr. M. E. Hard also gave a brief talk on "Mushrooms found in the Vicinity of St. Louis."

George T. Moore,
Corresponding Secretary

[1] *Trans. Acad. of Sc. of St. Louis*, Vol. XXI., No. 3.

SCIENCE

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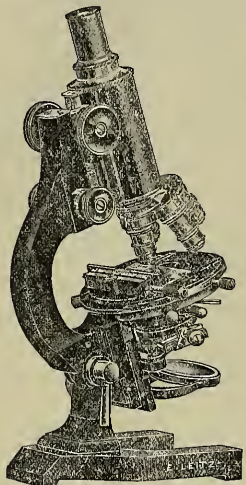

SCIENCE

FRIDAY, DECEMBER 13, 1912

CONTENTS

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THE PROBLEM OF ORGANIZATION

THE PROBLEM

THE contemplation of living beings has ever plunged the human mind into a state of perplexity and interrogation. So manifold are the aspects presented to us by the form and behavior of living things and so diverse are the minds which have sought to interpret the phenomena of life that we may at times feel ourselves submerged in a sea of distracting problems, uncorrelated theories and data which, while valuable, are more or less chaotic. From time to time, momentarily realizing that the particular problem which looms immediately before us, mighty and impregnable, is but one of a score or a hundred of equal importance, and that its solution would be for us as merely one sentence of a long story, we give vent to a question which at once epitomizes all of our perplexities and expresses the very heart of what we want to know. We ask, what is an organism? But this question, simple in form, yet all-inclusive, leads us nowhere. It is a blank wall offering no foothold for experimental attack. Should nature present to us no other question than this, she will ever remain a sphinx. For working purposes we must find questions which suggest a program of investigation. The following discussion states no new problem. Nor does it purport to be in any essential matter a new statement of the old problem of the organism. It is at most a restatement of the problem in terms which lay the emphasis at a point where it has been, perhaps, not so commonly put, but where for purposes of investigation I believe it may to advantage be placed. We will ask, not "what is an organism," but *what is organization?* The first question is too comprehensive and therefore vague and unworkable. The latter question, aiming at the very essence of what we want to know, enables us to turn from the distracting complexity of the entire organism to any observable part of it, the smaller and simpler the better, which exhibits that distinctive characteristic of the whole, *organization.*

A familiar form of anatomical description begins by stating that the morphological unit is the cell. Cells, then, are associated together to form tissues, which enter into the composition of organs. Several organs cooperating in a set of related functions constitute an organ-system. The whole animal, finally, may consist of several such organ-systems. A complete description of structure would lead us to a considerably greater degree of complexity, for we should find units intermediate between certain of those which we have just mentioned. Thus, the kidney as a whole we call an organ. But analysis resolves it, not immediately into tissues, but first into such secondary or lesser organs as renal tubules, renal corpuscles and blood-vessels.

Turning from the morphological to the physiological point of view, we observe a series of units of function precisely corresponding to the series of structural units. It could not be otherwise, for structure is merely the visible expression of function.

Whether we view the structural or the functional aspect of the animal, we see the component units so correlated and coordinated one with another that the result is a harmonious action of the whole in relation to a fairly well-defined set of external conditions. This systematizing of many lesser units into one greater unit is so striking a peculiarity of living things that we call them organisms.

Organization, however, is a peculiarity not merely of the animal or plant as a whole, but likewise, to a considerable degree of minuteness, of its constituent structural units. There are certain things which cells do quite independently of the fact that they belong to any particular tissue or animal. The fundamental processes of metabolism, growth and reproduction are inherent in cells. Obviously, a tissue cell has an organization within itself. So far as my present purpose is concerned, it would not now be profitable to speculate as to how far there may be still other self-contained organizations within and inferior to the cell. A tissue, likewise, has a certain organization within itself. There are certain activities which a tissue performs quite independently of the fact that it is a part of a particular organ or animal. Muscle tissue, removed under appropriate experimental conditions from the animal to which it belongs, exhibits its characteristic activities. The contraction of an excised piece of muscle is, to be sure, merely the resultant of the contractions of its constituent cells. I speak of it as a tissue act rather than a cell act in the sense that it is action of a specialized type—one not exhibited by cells in general but only by such cells as possess those peculiarities characteristic of muscle tissue. A small bit of epithelium transplanted into a foreign locality, or maintained under artificial cultural conditions, may exhibit its peculiar habits of growth. The essential function of an epidermis is to cover outside surface. If a portion of an animal is denuded of epidermis, the remaining epidermis, provided the wound is not too extensive, extends over and covers the exposed deeper tissues. If a small fragment of living animal material, including some epidermis together with deeper tissue, is isolated under proper conditions, the fragment may become more or less completely covered over by extension of the epidermis. This covering of outside surface by epidermis of uniform thickness and character is distinctly a tissue phenomenon due to a certain organization inherent in the tissue. It is not dependent, at least not necessarily dependent, upon the organization of the animal as a whole. A distinction between tissues and organs can not always be sharply made. However, it is clear that the action of an organ is not necessarily dependent upon the integrity of the animal to which it belongs. A vertebrate heart, under proper conditions of temperature and fluids, will continue its rhythmic action long after removal from the animal. (So, indeed, will an excised strip of its muscular wall.) An excised kidney long retains the capacity for functional activity. Under normal circumstances it is dependent for its oxygen and nutrition upon the animal to which it belongs. But in its organization as a kidney, it seems to be quite independent of the animal as a whole. And finally, there are activities which are distinctly functions of the animal as a whole—the hydra seizing and swallowing a cyclops, a dog following a scent, a cat fighting, a kitten playing. Here we see the animal acting as a unit. Its action is relatively simple and intelligible just as its external form is. But analysis of the action resolves it into a complex of physiological units corresponding to a complex of structures involving perhaps all of the subordinate organizations of the animal.

Comparing the units of these several grades of organization, the cell stands forth with peculiar prominence. It has always appeared so to the biological mind. The fact that every animal part, upon analysis, reduces to cells, the uniformity in size and visible structure of these bodies, make them conspicuous as universal morphological units. The tissue, and even the organ, is ordinarily much less definitely formed and limited, less sharply individualized. The organ-system is obviously a somewhat arbitrarily distinguished unit. In strict morphological sense, at the first step of analysis the whole individual resolves itself directly into organs. The natural tendency, then, is to regard the cell as the essential morphological and physiological unit. In fact, so important does the cell appear that we have been inclined to consider the relation between cell and organ, or even between the cell and the whole individual, to be a direct one rather than one which is indirect by way of such intermediate systems as may exist.

In presenting this familiar sketch of the plan of an organism, I use the word, organization, in its ordinary sense. It is not structure nor is it function. It consists in certain definite and obvious relations of functions, and therefore of structures too. It asserts nothing as to the nature of these relations and it implies nothing as to how they have come to exist. Just here we meet some serious biological problems. What is the nature of those relations which constitute organization? How do they come into being? By what and how is it determined that a group of cells shall be associated together to constitute an epithelium of definite and constant thickness and character? In muscle tissue how does it come about that thousands of cells are substantially alike and capable of operating harmoniously together in response to an effect received from nerves? What is it that affects a mass of tissue of a certain kind in such a way that it assumes the form and position appropriate to its participation in the tissue complex of an organ? What determines those mutual relations whereby diverse organs operate harmoniously together in the service of the whole?

Our conception of the organization of living things must remain imperfect and incomplete until such questions as these are answered. When they have been answered we may, in the light of our increased knowledge, amplify and perfect our definition of the word, organization. Or, if we prefer, the word may be retained in its present significance as applied to plants and animals, indicating those relations which even now we clearly enough perceive to exist, and we may use some other designation for whatever shall have been found to underlie these relations. I am using the word to designate those conspicuous peculiarities which have led us to call living things organisms. Our problem is to discover upon what this organization rests.

HYPOTHESES

The inquiry as to the nature and underlying basis of the relations which constitute organization meets two alternative answers. According to the one we may regard the constituent elements of any organic system—be it cell, tissue, organ, or the whole individual—as causally independent of one another *so far as their condition of being organized into a system is concerned,* and we may suppose further that no dynamic agent specifically responsible for their organization into a system exists. The fact that the constituent elements of the system do depend upon one another in a variety of ways and that they do stand in diverse definite relations to one another constitutes their organization. But the cause of the organization of the system does not necessarily lie within the various interrelations of the several members of the system, nor in any effects derived from other organic systems. Each element possesses a certain constitution. It exists in a certain physical, that is, nonphysiological, environment. (The physical peculiarities of this environment may, however, be to a great extent dependent upon the physiological operation of other organic elements and systems.) It executes activities which are direct functions of its constitution and environment. If these activities take place in such a way as to produce harmonious action of the several members of a group, thus constituting them into a system, such harmony is to be regarded as merely the incidental result of the circumstance that the members are so constituted and so environed. The member is in no way responsible for the fact that its behavior is subserving the needs of the entire organism, and no more is the organism as a whole responsible for the behavior of its elements.

Viewed in this way, the organization of any system results essentially from peculiarities in the constitution of the members of that system, the members being not only independent of one another as regards the fact of their being organized, but likewise independent of any immediately present coordinating agent. Organization, then, is merely something that we read into natural phenomena. It is in itself nothing. Going to the logical conclusions of the matter, it is a name for certain inevitable and purely accidental consequences of the circumstance that atoms or other primordial physical entities possess certain inflexible habits of movement. If we are perplexed by the fact that the total effect of the operation of a subordinate system appears as a more or less important function in the physiological economy of the whole animal, we need only consider that, had it been otherwise, the "struggle for existence" must have long since made an end of the matter.

An alternative view attributes the harmonious operation of a system to the action of some dynamic agent or energetic complex which exercises general control over the members of the system. These members must be similarly constituted in order that they may properly respond to the controlling agent. The control may be conceived to consist in the action of a superior dynamic agent upon an inferior system, or in some effect of the system as a whole upon its individual members.

It is quite obvious that the activity of one organ does affect the tissues and cells of other organs and that the units of one system are dependent in a variety of ways upon other systems. An epidermal cell is dependent upon the digestive, respiratory, circulatory and excretory systems, and less directly upon the nervous and other systems. There are numerous other relations, perhaps equally important even if less obvious, such as exist between the ductless glands and other organs and tissues in vertebrates. Indeed, it appears likely that we are at present very far from a complete knowledge of the extent to which internal secretions or hormones may serve in the correlations of organs. In ontogeny hormone action may play a rôle of utmost importance as a "mechanism for organic correlation."[1] The nervous control of muscular, secretory and other activities affords what is, in a sense, the most conspicuous instance of control exerted by one part over another part. But while such relations as those involved in nervous control and hormone action may be absolutely essential to the normal operation of the various organs and systems of the animal, it by no means necessarily follows that such relations involve any *general control* of the *organization* of the elements of one organ by the action of another organ. So far as the nervous system is concerned, quite the reverse may be true. An agent which controls certain activities of a group of elements may in no way be responsible for the fact that those elements are capable of responding to its control. The relation of the nervous tissue to the muscle tissue may be exceedingly limited in that it is perhaps only the processes concerned with contracting that are under nervous control. The general organization of the muscle is not, so far as we know, due to nervous control. Professor R. G. Harrison and his co-workers have achieved results of far-reaching importance in demonstrating that the ontogenetic differentiation of muscle tissue is independent of any action of the nervous system. In the fully differentiated muscle tissue exists an organization which renders the tissue capable at any instant of proper response to nervous stimulation. What is it that maintains this organization in the muscle? An answer to the question may be offered by asserting that the histological peculiarities of muscle tissue are due to germinal preformation, and having been so determined and developed, they persist. This may or may not be satisfying. Tissue cells are not structures like stone blocks laboriously carved and immovably cemented in place. They are rather like local eddies in an ever-flowing and ever-changing stream of fluids. Substance which was at one moment a part of the cell passes out and new substance enters. What is it that prevents the local whirl in this unstable stream from

[1] Parker, G. H., 1909, "A Mechanism for Organic Correlation," *American Naturalist*, Vol. 43, April, pp. 212–218.

changing its form? How is it that a million muscle cells remain alike, collectively ready to respond to a nerve impulse? If germinal preformation answers the question, the nervous system is relieved of any responsibility for the maintenance of organization in the muscle tissue. The nervous system exercises occasional instantaneous effects upon the muscle, resulting in one particular kind of activity. So far as this relation is concerned, there is no evidence of general control exerted by nervous tissue over muscle tissue. Even the more or less continuous tonic effect of nerve on muscle does not prove the existence of any control beyond the observable tonic effect itself.

With the case of internal secretions the matter stands much the same. That a substance poured by one gland or tissue of the body into the blood stream may produce most important and specific effects upon other tissues or organs has been demonstrated beyond doubt. The secreted substance may be one in whose absence certain definite abnormal conditions arise, as in the case of the thyroid. Or it may be one whose presence is somehow connected with the perfectly normal development of an organ, as in the relation between gonads and secondary sexual organs. But in all these relations which are established by the transmission of nervous impulses or specific substances from one part of the body to another, we find no answer to the question which we have stated. Upon the contrary, the more of these relations we discover, the more intricate does our problem become, for it is precisely these relations which constitute organization. They are the materials of our problem, not evidence toward its solution.

Any one of these relations is open to either of the two interpretations which I have stated. View the animal, if possible, without the prejudice which arises from the knowledge that it is an organism. View it as if it were a non-living dynamic complex. The nervous system at once loses its paramount importance. It appears as a system coordinate with several other systems. It no more controls other systems than it is controlled by them. True, certain conspicuous events in muscle are conditioned by something that happens in nervous material. But, so far as we can clearly see, it may be equally true that every operation and event in the nervous tissue is conditioned more or less directly by activities going on in other systems or otherwise outside of the nervous system. The nervous tissue appears as a group of elementary organisms of peculiar form, existing in an environment in which they find the materials requisite for their maintenance. They receive more or less intermittent influxes of energy from this environment and, in turn, discharge it in a more or less modified form. In muscle tissue we see another group of elementary beings, muscle cells, whose habitual environment subjects them to certain energetic actions to which they exhibit a fixed type of reaction. And so it is throughout the whole organism. The substance or the energy which is given off by one element as a by-product or a waste product of its activities becomes a peculiarity of the environment in which other elements habitually carry on their existence. It is a vast symbiosis. It is comparable to the relation which exists between the plant life and the animal life of the globe. Green plants need carbon dioxide and give off oxygen. Animals need oxygen and give off carbon dioxide. And so they live successfully together. But would any one venture to propose that the internal organization of animals is determined and controlled by plants, or that of plants by animals? There is no more ground for asserting that the organization within a subordinate organ of the individual plant or animal is determined and controlled by another organ from which the first receives some form of energy or some substance. It is clear that the secretion of the thyroid affects the integument. In the absence of that secretion the integument becomes altered in character. But it does not become disorganized. Its cellular elements remain organized as integumentary tissue, but with changes in the details of that organization. There is no ground for attributing the fundamental fact that certain cells are organized as integumentary cells to the influence of the thyroid secretion or any other secretion contained in the body fluids.

The whole process of organic development may possibly be described in terms of hormones. If that shall come to pass, a considerable degree of complication will have been added to our conception of the process of ontogeny and our information will have been vastly enlarged. May such an achievement be regarded as bringing us one step nearer our goal of understanding the nature of the organization upon which development rests? Only in the sense that it is one step of an infinite number of steps of that particular kind which separate us from the goal. To discover a mechanics of development in terms of hormones is to bring within our cognizance additional facts of organization. No such description will reveal to us the essence of organization. I do not mean to discredit the search for mechanism. Just so far as mechanism exists we must know about it, for we seek the complete truth about organisms. It is conceivable that practical benefits of inestimable importance may follow from a complete knowledge of organic mechanism. But the nature and origin of mechanism are not to be found by discovering more mechanism.

It appears possible that the development of the lens of the vertebrate eye depends upon some effect proceeding from the optic vesicle. But even if this relation is fully proved, the problem of the development of the lens is by no means solved. The invagination of the ectoderm to form a lens may depend upon contact of the optic vesicle with the ectoderm, or upon the action of a substance given off by the optic vesicle. Any such relation between the two structures is open to either of the two interpretations which are before us. The invagination of the lens ectoderm involves what looks to us like concerted action upon the part of numerous cells. We may suppose that each cell possesses an inherent mechanism which, under the conditions in which the cell normally finds itself, compels the cell to play just that particular part in lens development which it does play. This inherent mechanism depends, we may suppose further, upon germinal preformation which in the last analysis, if this view is carried to its logical consequences, depends upon chance combinations of atoms and the accidents of selection. It is a peculiarity of the environment in which the cells live that at a certain time an effect is produced upon them by a group of underlying cells (assuming the relation between the optic vesicle and the lens to have been proved). It happens that this effect introduces precisely the conditions needed to set going the separate mechanisms in the several cells. Upon this view the organization within the ectodermal layer—its organization as ectoderm and such more or less localized organization within it as renders it capable of producing lenses—is in no way determined by the action of the optic vesicle. The effect proceeding from the optic vesicle serves merely as the trigger to set off the separate mechanisms of the superficial cells. We may conceive the cells, then, to be absolutely independent of one another in the matter of lens formation. Their concerted action is the purely accidental result of the fact that they suffered simultaneously a change in their environment, that is, the effect derived from the optic cup. This effect merely initiates the development of the lens. Neither the ectodermal organization which causes that development nor the process of development is determined by the optic vesicle. Even if lens development required the continuous action of an effect from the optic vesicle, this view of the relation need in no wise be altered, for that continuous action would constitute merely a persistent feature of the environment appropriate to the operation of the separate mechanisms of the ectodermal cells. It is possible, as some experimental data seem to indicate, that regions of ectoderm remote from those which normally give rise to lenses are capable of producing lenses as a result of the action of transplanted optic vesicles.[2] If this is true, the fact would seem to put considerable strain upon the view just outlined. Nevertheless, it is always possible to buttress up a favorite hypothesis with subsidiary hypotheses. If the main thesis is highly esteemed, often some very complicated accessory hypotheses will be tolerated. I am sure that any such difficulty as the present one—and the experimental work upon embryos has yielded many such—will readily yield to this treatment. I will leave the task for those to whom this conception of organization is the favorite one.

What other interpretation can be put upon this matter of lens formation? The essential feature of the process is the concerted action of ectoderm cells. We may regard this concerted action as due to an agent which immediately exercises general control over the behavior of all the cells concerned. If it is true that the optic vesicle has something to do with the invagination of the lens, it is conceivable that the substance of the optic vesicle is a seat of energy which is somehow brought to bear upon the near superficial ectoderm, with the result that its cells are compelled to execute those changes of form and relative position which are involved in the shaping of a lens. We should have to attribute to the ectoderm cells similarity of structure and an inherent mechanism sufficient to render them capable of responding to the control of the optic vesicle. The expression "concerted action of ectoderm cells" should not convey the impression that every cell behaves precisely like every other. Obviously such can not be the case. The lens invagination is not exactly hemispherical. The changes in form and position of the cells must vary according as whether the cells come to lie nearer the axis or nearer the periphery of the invagination. Upon the first view which we have outlined, the factors which determine the differences in the behavior of the individual cells are contained within the mechanisms of the independently acting cells themselves. Upon the second view, which we are now presenting, the differential factors of lens formation lie outside the group of lens cells. So far as internal conditions are concerned, those cells may be precisely alike.

[2] Lewis, W. H., 1904, "Experimental Studies on the Development of the Eye in Amphibia," *American Journal of Anatomy*, Vol. 3, No. 4, pp. 505–536. See also later papers by the same author.

Upon the first, then, of our two views of lens formation, the lens is determined from within; upon the second view it is determined from without. By the first view we see the lens arising as, in strict sense, a purely accidental resultant effect of the operation of many mechanisms which are essentially independent of one another and independent of any external factor which compels their harmonious behavior. By the second view we conceive of an energy or energy-complex, situated perhaps in the substance of the optic vesicle, exerting itself upon a group of ectoderm cells and thereby coercing them into lens formation. In this case the ectoderm cells may be essentially alike and independent of one another, but they are collectively dependent upon an external controlling agent. The external energy-complex plus suitable ectoderm constitutes the formula for a lens. By transplanting the optic vesicle the first member of the formula may be brought into relation with a region of superficial ectoderm remote from that which normally gives rise to a lens. A lens must result there, as elsewhere, provided that the ectoderm in the newly affected region is not too unlike the normal lens ectoderm.

A group of particles of iron in a magnetic field assumes an orderly configuration under the influence of that field. A rough analogy exists between this phenomenon and the hypothetical relation between a group of ectoderm cells and a lens-determining force-complex originating in the optic vesicle or elsewhere. If, however, we succeed in imagining that each particle, in virtue of certain inherent peculiarities and independently of any agent which immediately controls the behavior of the particles collectively, assumes a certain position, and if we can imagine further that, as the outcome of a chain of entirely fortuitous circumstances in the past history of the particles, their several positions are such as to give the whole group an orderly configuration, we shall have illustrated our first conception of the nature of organization. Another illustration presents itself employing, instead of iron particles, mechanisms of considerable complexity and in so far offering greater similarity to what we see in plants and animals. Suppose that ten clocks, precisely alike in construction, strike the hours in unison. So long as the clocks are similarly affected by temperature, moisture and other external conditions, and so long as their energy holds out, they will continue striking the hours in unison—a tissue of clocks. We can imagine that the air vibrations produced by the striking serve to set off some other mechanism. But the mechanism of each clock is entirely independent of that of all the others. Further, so far as the several clocks themselves are concerned, there is no connection whatever between their striking and the setting off of some other mechanism. The air vibrations (a hormone) which transmit the effect from the clocks are something outside of and distinct from the clocks themselves and the responding mechanism as well. A human observer, noting that the clocks keep the same time and strike in unison, and noting that the initiation of a certain activity in another mechanism depends upon something that the clocks do, applies to these several relations the name, organization.

To illustrate the other conception of organization, we may suppose each of the ten clocks to contain a striking mechanism which, for its operation, requires that the clocks shall be affected by an electro-magnetic field. The clocks do not strike at all, then, until by the action of agents outside of themselves they come within the influence of such a field. They then strike in unison. We may even suppose that there exists a regulatory arrangement such that, if some clocks are running slow and others fast, the mechanism involved in striking serves automatically to restore the clocks to synchronous action. In this latter illustration the striking of the clocks depends in part upon their like construction. But the action of an electro-magnetic field is another and an essential factor in their concerted behavior. It is an agent entirely outside of the clocks themselves which exercises a general control over their activities.

In the first illustration of the clocks the striking in unison consists, so far as we can see at the moment, in the coincident acts of ten absolutely independent and self-contained mechanisms. In the second case there is immediately present a specific coordinating agent which compels the several mechanisms to united and harmonious action. In the absence of this agent the ten clocks would not strike together—they would not strike at all—nor would they keep time together. Viewing such a group of objects, we should see merely ten distinct mechanisms lacking any coordination into a unit or a whole. These illustrations hold only if not examined below the surface. Any inquiry as to how and why the clocks came to be constructed as they are and, in the first illustration, to be wound up, set together, and so precisely regulated as to keep time exactly together, will greatly complicate matters and will render the appropriateness of the illustration more or less dubious.

In this conception of organization as being dependent upon an agent which exercises general control over the elements which are organized, we are not limited to the idea that the control operates from without the group of elements. In the case of the lens we may equally well imagine that the controlling agent is in the lens ectoderm itself; not, however, as embodied in the separate mechanisms of the several cells, but as something which transcends cell mechanism, pervading, so to speak, the whole region of lens ectoderm. Upon this view a formative effect exerted by the optic vesicle upon the lens may be supposed to consist in a stimulus—merely a signal—which serves to initiate the action of a lens-determining agent in the superficial ectoderm. The development of a lens at places other than where a lens normally develops obviously presents difficulties to this hypothesis. We may think of this internal lens-determining agent as operating either by effects upon the individual cells or by action upon the ectodermal protoplasmic sheet as a whole, regardless of cells. Whitman, in 1893, in his paper on "The Inadequacy of the Cell-Theory of Development"[3] gave us a vivid picture of living substance developing into organic form through the operation of large force complexes which express themselves in thickenings, foldings, and the great variety of form changes seen in embryonic layers, irrespective of the subdivision of these layers into cells. At the present time there is a distinct tendency away from any such broad and relatively simple conception of developmental processes toward those which involve overwhelming multiplicity of determining factors and indefinite minuteness of structural mechanism. The current hypotheses which have had their inception in the Mendelian discovery and in correlated cytological research tend toward exaltation of the importance of the cell and more particularly of the chromosome, if not of yet more minute and less accessible elements into which the chromosome is hopefully to be shattered. Yet I believe that the status of the

[3] *Journal of Morphology*, Vol. 8, pp. 639–658.

chromosome is neither biologically nor philosophically so secure as to warrant us in contemptuously rejecting any hypothesis which fails to bow to the chromosome as the omnipotent ruler of organic form.

The first of our alternative views of organization attributes such harmonious and concerted action as we frequently see within a group of similar structural elements—for example, in a simple epithelium consisting of numerous cells which are structurally and functionally alike—to homogeneity in that complex of factors, internal and external, which affects the several members of the system, one factor being as essential as another, and no one factor being especially responsible for the concerted action exhibited within the system. If any one of these factors be removed, provided that it be not one which is directly essential to the existence of the system, the system immediately affected becomes no less organized, but merely undergoes some change in its organization. This change may be one which interferes with the operation of some larger system and perhaps results in the downfall of the whole organism. In such a disaster we see the selective action of "Nature" tending toward the firmer establishment of harmoniously and advantageously operating systems. A certain condition may be essential to the existence of a system, yet in no way responsible for the peculiarities of that system. Oxygen is essential to the existence of a dog, but oxygen is not responsible for the fact that certain living substance is organized as a dog and not as a cat.

In general, then, the first alternative asserts that organized form arises ontogenetically, and is maintained, by the operation of a multiplicity of factors which, for each particular of that form, are coordinate in rank and are associated together just as they are, not by any immediately present and directly operative necessity, but only indirectly through those several necessities which have arisen from circumstances in the past history of the genetic series. When these factors are associated into a homogeneous complex, the resulting type of organization is such as we see in a tissue whose numerous cells are alike in histological differentiation. The shaping of tissues into organs implies a precisely corresponding departure from homogeneity in the complex of factors concerned. The modification or disappearance of any one or several of these factors is not necessarily followed by loss of organization, but only by change in the relations which constitute organization.

The second alternative, while admitting that organization must involve a multiplicity of factors, asserts that amongst these is one factor, or a group of factors, of dominant importance. This dominant factor may conceivably determine structural uniformity and concerted action even when the other factors affecting the system constitute a complex which is not exactly homogeneous. Upon the other hand, we can imagine that the operation of a localized dominant factor in a system otherwise marked by perfect homogeneity of conditions produces the differentiation of a portion of that system into a system of higher order, as when a region of a germ-layer is modified into an embryonic organ. With the removal of the dominant agent, all other factors remaining the same, organization of a certain grade completely disappears, although organizations of lower order may remain. A case which conceivably may prove to be an illustration of this hypothesis is afforded by the headless fragment of worm which, while remaining alive for a considerable time, does not regenerate. The living fragment exhibits organizations of the various grades corresponding to organs, tissues and cells. But the agent which dominates these lower organizations and produces the organization into a whole individual has somehow disappeared.

The first view we may conveniently designate as the theory of autonomous elements, understanding that this autonomy does not preclude the possibility that the environment in which each element lives may depend in a great variety of ways upon the operation of other systems. The second view we may call the theory of controlled elements or the theory of dominance, referring to the existence of specific agents which dominate and coordinate the form and behavior of structural elements.

The problem of organization in the form in which I have here stated it has no definite relation to that problem of ontogeny whose alternative and opposed answers have from time to time and with ever shifting significances borne the names preformation (or evolution) and epigenesis. The theory of autonomous elements associates itself very consistently with the idea of a considerable degree of rigid germinal preformation—mosaic development. Nevertheless, a scheme of development which is to the fullest possible extent epigenetic may be thought of as depending essentially upon the ever-changing environment of each individual element, the orderly series of successively determined stages proceeding in the total absence of specific form-determining agents exercising immediate control over groups of elements. The theory of dominance may likewise be consistently linked with either conception of the mode of development. Let it be assumed that the harmonious operation of any ontogenetic system, such as the concerted action of the entoderm cells in gastrulation, be due to the presence of an agent which coerces the elements of the system into that particular form of behavior, even in spite of some differences which may exist amongst those elements and in spite of some degree of inequality in their several environments—an agent in whose absence there would be no concerted action at all. We then have our choice of these two alternatives. We may attribute the existence and timely operation of the control agent directly to some peculiarity of the germ—preformation; or we may suppose it to arise as a function of the preceding stages in development, being thus only indirectly related to the original germ organization—the epigenetic view.

Neither does the line between our two conceptions of the nature of organization coincide with the line separating those two groups of theories known as mechanistic and vitalistic. This statement can the more confidently be made in view of the fact that there is serious disagreement as to where the latter line really lies. The theory of autonomous elements leads almost necessarily to a mechanistic view of the organism. Factors which are in any sense to be regarded as vitalistic could scarcely be introduced save by actual violence. The theory of dominance, however, affords ample latitude for the extremes of these two groups of opposed philosophical attitudes. If it is possible to imagine that the harmonious action of a system is the resultant effect of the coincident operation of the mechanisms of its autonomous elements, it is equally possible to imagine that mechanisms have arisen on a larger scale, not confined within the limits of a single element, but embracing groups of elements. To think of such a larger mechanism operating through or by means of the elements embraced within its scope, or operating within the substance of a group of elements irrespective of its subdivision into elements, gives us the picture of a system whose harmonious operation depends upon an agent which dominates all the elements or all the substance within the system. The lesser mechanism of the autonomous element in the one hypothesis and the greater control mechanism of the other hypothesis may equally well be regarded, if one is philosophically so disposed, as being the marvelous outcome of the accidental conspiracy between molecular structure and a selectively acting environment. Upon the other hand, a living being in which extensive groups of elements, physically more or less distinct and even heterogeneous in character, are in a large way dominated by agents which mold form and direct action, offers to the vitalist, of whatever type, a realm in which non-physical, ultra-physical or psychic factors and forces may be created and set going to the limit of his bent.

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(*To be concluded*)

THE GROWTH OF CHILDREN

PREVIOUS investigations have shown that the rate of growth of the body, measured by weight and stature, increases very rapidly until the fifth month of fetal life. From that time on the rate of growth decreases, first rapidly, then more slowly until about four years before the age of puberty. During adolescence the rate of growth is considerably accelerated, and decreases again rapidly after sexual maturity has been reached. Thus the curve of growth represents a line which possesses a very high maximum at about the fifth month of fetal life. It decreases rapidly, and has a second, although much lower maximum shortly before sexual maturity is reached, and not long afterwards reaches the zero point.

The bulk of the body of girls and boys is approximately equal until the period of adolescence. Since this sets in much earlier in the female than in the male, the concomitant acceleration also sets in at an earlier time, with the result that for a few years girls are larger than boys.

The periods of most active growth of the various parts of the body differ considerably. Nevertheless, it would seem that the characteristics of the curve of growth as here outlined are repeated in many if not in all organs and parts of the body. For instance, although the head reaches nearly its full size at an early time, so that its rate of growth shows a much more rapid decrease with age than that of the bulk of the body, there is a slight acceleration of growth during the period of adolescence.

It might seem, judging from the data just mentioned, that the difference between the sexes does not develop until the period of adolescence; but a study of the eruption of the teeth which I made a number of years ago, and the more recent interesting investigations by Rotch and Pryor on the ossification of the carpus, show that the difference in physiological development between the two sexes begins at a very early time, and that in the fifth year it has already reached a value of more than a year and a half.

I give here a tabular statement of the available observations:

	Age in Years		Difference
	Boys	Girls	
Ossification of scaphoid	5.8	4.2	—1.6
Ossification of trapezoid	6.2	4.2	—2.0
Eruption of inner permanent incisors	7.5	7.0	—0.5
Eruption of outer permanent incisors	9.5	8.9	—0.6
Eruption of bicuspids	9.8	9.0	—0.8
Minimum increase of annual growth	10.3	8.2	—2.1
Eruption of canines	11.2	11.3	+0.1
Maximum increase of annual growth	13.2	11.2	—2.0
Eruption of second molars	13.2	12.8	—0.4
Maximum variability of stature	14.8	12.4	—2.4

These data are not very accurate and must be considered a first approximation only.

When we remember that growth depends upon physiological development, it will be recognized that we must not compare the stature of girls of a certain age with that of boys of the same age, but that from the fourth year on a girl of a certain age should be compared with a boy a year and a half older than she is.

If this view is correct, then it appears that the relation in size of the two sexes persists even in childhood.

I think no better proof can be given of the correctness of this view than the peculiar behavior of those parts of the body which complete their growth at a very early time; for instance, that of the head. The total amount of the growth of the head from the second year on is very slight. If, therefore, girls are ahead of boys in their development by about a year and a half or two years, the total amount of growth of the head in their favor will be the small amount of growth accomplished during this period of a year and a half or two years. If, then, there is a typical difference between the size of the body of male and female in childhood of the same character as found in adult life, then the head of the girl ought to be at all periods smaller than the head of the boy; and this is what actually happens. The phenomenon has been interpreted as indicating a less favorable development of the head of the woman; but the previous remarks show that it is obviously due solely to the different rate of physiological development of the two sexes. The results of psychological tests which show very generally that girls do better than boys of the same age, may be another expression of the general acceleration of their development.

Based on these observations, we may speak of a curve of growth and development of the whole body and its organs which has characteristic values for each sex and for each moment in the life of the totality of individuals that compose a social group. Not each individual, however, passes through these stages of development with equal rapidity. The mean square variability of the chronological age at which a certain point in the physiological development of an individual is reached is contained in the following table:

Age	Observations	Variability
0.0	Pregnancy	± 0.04
0.6	First incisors	± 0.21
1.6	First molars	± 0.31
4.2	Ossification of scaphoid bone, girls	± 1.4
4.2	Ossification of trapezoid bone, girls	± 1.2
5.8	Ossification of scaphoid bone, boys	± 1.1
6.2	Ossification of trapezoid bone, boys	± 1.3
7.0	Inner permanent incisors, girls	± 1.6
7.5	Inner permanent incisors, boys	± 1.4
8.9	Outer permanent incisors, girls	± 2.1
9.0	Bicuspids, girls	± 2.8
9.5	Outer permanent incisors, boys	± 2.1
9.8	Bicuspids, boys	± 1.6
11.2	Permanent canines, boys	± 1.4
11.3	Permanent canines, girls	± 1.0
12.7	Beginning of pubescence, boys	± 1.6
12.8	Second molars, girls	± 1.6
13.2	Second molars, boys	± 2.0
14.6	Completed pubescence, boys	± 1.1
14.9	Puberty, girls	± 2.0
19.3	Wisdom teeth, boys	± 2.1
22.0	Wisdom teeth, girls	± 1.8
35.0	Preauricular wrinkles	± 6.6
36.5	Hair on tragus	± 8.3
44.5	Menopause	± 5.3
62.5	Death due to arterial diseases, men	±13.2

It appears from this table, which may be represented in the form of a curve, that the variability of the physiological stages of development increases very rapidly—roughly speaking, so that its logarithm is about proportional to the actual age, or, to use the term applied by Dr. Crampton and Professor Rotch, to the "chronological age." The causes that lead to this rapidly increasing variability are so far entirely unknown. It is certain, however, that there must be definite causes at work which bring about this phenomenon; for, if the variability were due to accidental causes only, it would increase considerably slower than in a ratio proportional to the increasing age. The study of the general curve indicating the increase of variability in physiological development indicates an irregularity at the time of approaching maturity. At this period the variability seems to increase at an unusually rapid rate, and either to be stationary or to decrease again at a later time.

I have spoken here of the variability of the physiological development of the body as though this were a unit. In 1895, in a discussion of Professor Porter's observations on the growth of school children in St. Louis, I pointed out the fact that a general variability in physiological development accounts for the close correlation between the distribution of ages in school grades and the size of the body and its organs; and this problem was later on worked out by myself in conjunction with Dr. Clark Wissler in regard to various measurements. These correlations have also been proved in a most interesting manner by Dr. Crampton's observations on pubescence, and by Professor Rotch's and Pryor's study of the development of the epiphyses and carpal bones. It is true that a close correlation between the status of the physiological development of the various parts of the body exists, but there exists also a certain amount of variability in the development of an organ when another one has reached a definite stage. The correlation is so close that the condition of the bones or that of pubescence gives us a better insight into the physiological development of the individual than his actual, chronological age, and may therefore be advantageously used for the regulation of child labor and school entrance, as Rotch and Crampton advocate; but we must not commit the error of identifying physiological development with physiological age, or of considering chronological age as irrelevant. The clearest proof that is available is found in the data relating to increase of stature, and in observations on pubescence made according to Dr. Crampton's methods. Bowditch was the first to investigate the phenomena of growth of individuals who are short or tall at a given age, but his method was based on a statistical error. Later on I showed that retarded individuals possess a late acceleration of growth, and these results were amplified by studies made by Dr. Beyer and Dr. Wissler. Recently I had occasion to make a more detailed statistical analysis of the phenomena of growth, which show that individuals whose prepubertal accelerated growth begins late in life have rates of growth that exceed by far those of the normal individual; in other words, that among the retarded individuals the whole energy required for growth is expended in a very brief period. In the case of stature the phenomenon is complicated by the great differences in hereditary stature among the various parts of the population. It appears more clearly in observations on pubescence. The observations indicate that if the first pubic hair appears in one group of boys at eleven and a half years, in another at fifteen and a half years, it will take the former much longer than the latter to attain the full development of pubic hair, and the rate of change found among them will be much greater than that of normally developed individuals. Although further data are required to determine this point definitely, it is certain that we must not assume that individuals who exhibit the same stages of physiological development are the same, physiologically speaking, no matter what their actual age may be; on the contrary, the past and prospective physiological changes in their bodies will proceed in different manners. It is clear, therefore, that the greater the retardation or acceleration in any one particular respect, the greater will also be the disharmonies that develop in the body, since not all the other organs will follow the same rate of acceleration and retardation.

The causes of these phenomena are unknown; but we may perhaps venture on the hypothetical explanation that all the cells of the body undergo certain progressive changes with increasing age, and that the internal secretions which become active at the time of puberty exert a stimulus upon the cells which causes accelerated growth in the cells, and that the intensity of this influence depends also upon the state of development of these cells. This may refer to the whole body as well as to the glands that have a direct influence upon the rate of growth. In retarded individuals many of the cells have advanced in their development more nearly normally than the groups of cells involved in sexual maturity; and when their action sets in, the cells of the body are stimulated much more vigorously than the less developed ones of an individual that reaches maturity at an earlier time. This hypothesis, however, would have to be tested experimentally. It is intended only to bring nearer to our understanding the complicated phenomena of retarded and accelerated growth.

It seems very likely that the abnormally large amount of energy expended upon rapid growth during a short period is an unfavorable element in the individual development. A study of the phenomena of growth of various groups of the same population has shown that early development is a concomitant of economic well-being, and that a characteristic of the poor is the general retardation in early childhood, and the later rapid growth. It follows from this that there is a corresponding, although not equal, retardation in early mental development, and a crowding of developmental processes later on, that probably place a considerable burden on the body and mind of the poor, which the well fed and cared for do not bear. The general laws of growth show also that a retardation kept up for an unduly long period can not be made up in the short period of rapid growth; so that it would seem that, on the whole, excessive retardation is an unfavorable element in the growth and development of the individual. Whether there are similar disadvantages in a considerable amount of early acceleration is not so clear.

Franz Boas

Columbia University

THE WORK DONE BY THE GERMAN SUBCOMMITTEE ON THE TEACHING OF MATHEMATICS[1]

I regret very much, that Mr. F. Klein, Göttingen, the president of the German subcommittee of the International Commission on the teaching of mathematics, is not able to come to Cambridge. It thus happens that I have the honor, in his place, of presenting to you the following short report of the present state of the work done in Germany.

When we consider the historical development of the German empire, it is very evident that we should not expect to find a homogeneous system of schools, controlled by a central board of education, as is usually the case in other countries. The various sections of the German people may be looked upon as different sources of the stream of German culture. Furthermore, the religious reformation tended to increase the variety of the German schools; for while in some parts of Germany the schools of to-day can be traced directly to the ancient cloister-schools, in other sections of the country there is not such a connection apparent. And finally the modern development of Germany from an agricultural state to an industrial one has also had a large influence on the formation of schools, so that a great difference in types must be expected and actually does exist.

A recognition of all these influences, the political, the religious and the economical, is essential to a complete understanding of German education, and they are therefore in evidence in the general plan of the German report as well as in the individual essays of which it consists.

The German report[2] is composed of 5 volumes, treating:

I. The secondary schools of northern Germany.

II. The secondary schools of southern and middle Germany.

III. Special problems of the secondary mathematical instruction.

IV. The mathematics at the technical schools.

V. The teaching of mathematics in elementary schools, and in the seminaries or training schools for elementary teachers.

These five volumes will comprise 36 individual reports and I have the honor to present 27 of them to the congress.

The German subcommittee has succeeded in engaging a staff of specialists in the various fields of mathematical instruction, and it has taken care to harmonize all the single reports with the general plan. The president, Mr. Klein, had the general supervision of all

[1] Report presented at the meeting of the Fifth International Congress of Mathematicians, at Cambridge (England), August 23, 1912.

[2] "Abhandlungen über den mathematischen Unterricht in Deutschland, veranlasst durch die Internationale Mathematische Unterrichtskommission," Herausgegeben von F. Klein, Leipzig, B. G. Teubner.

the volumes, being assisted by Mr. Lietzmann, the secretary of the German subcommittee. Furthermore, Mr. Klein gave special attention to the volumes I., III. and V., while the second volume was due in large measure to Mr. Treutlein, one of the most prominent of our secondary teachers, whose death, three weeks before this congress, is a great loss to our country. Volume IV., which relates to the mathematics at the technical schools, is largely in the hands of Mr. Staeckel.

At first sight it might be expected that the report would begin with the elementary schools, proceeding then to the secondary schools and finishing with the institutions of university rank. It is not possible, however, to give such a systematical description of the German schools. The variety is too great, the development of the different types of schools too peculiar, the mathematical instruction too varied, to make it possible to arrange our school-system in a straight line.

The points of view that have been set forth in the several papers can not be completely given in this short report. I may say, however, that in general there is given in every case a sketch of the historical development and of the organization of the special types of schools. Perhaps you will allow me to call especial attention to the fact that the reports of the German delegation not only present a fairly adequate picture of the mathematical instruction, but also of the whole German system of schools.

In order to set forth a general summary of the German reports, without entering into details, I beg to call attention to the third volume, which contains the discussion of certain general questions of the secondary mathematical instruction, and to mention in some detail the several papers.

During the last 10 or 20 years the reform of the teaching of mathematics has often been discussed not only in Germany, but in all cultivated countries. Therefore it is of interest that the first paper of the third volume is especially devoted to the development of these reform tendencies in Germany.

The second paper treats of the relation between mathematics and physics in the secondary schools, showing by numerous examples the great value of physics when founded on a high grade of modern mathematical instruction. We may assume that this paper will have a good reception in the native country and in the university of Newton.

The following three papers treat of applied mathematics, and especially of descriptive geometry, astronomy and practical arithmetic. These are followed by an essay on the history of mathematics as a means for raising the interest of the student in the subjects of the secondary school.

The last essay of the third volume that just appeared sets forth the relation between mathematics and philosophy. It shows us how the higher classes in mathematics in the secondary school receive a valuable training in philosophy as well. I am of the opinion that this paper will be found to contain much that will prove to be of value and of general interest to all readers.

Though all of the volumes of the German report treat more or less at length of the training of teachers, nevertheless it has been thought desirable to prepare a special paper on the study of mathematics at the German universities since 1870. I am sorry to say that this report is not yet printed, but it is just going to press. I need not urge the great importance of such a report, for it is evident that the education of teachers is the center of any substantial educational reform.

The reform of mathematical instruction is extending itself everywhere in Germany, and this tendency naturally leads, little by little, to a standardization of the instruction in the different parts of the country. But in spite of this tendency it must be said that, in matters of public education, Germany enjoys very great freedom. I dare say that this freedom is a notable characteristic of our country, and that there exists scarcely an analogy in any other of the leading countries of the world. I may illustrate this liberty of teachers and of the educational system by two examples: First, in Germany the teachers are merely obliged to follow certain general outlines given by the minister of public instruction, without being slavishly bound to the text-books that are used in their schools; and second, the problems for the "Abiturientenexamen" (our finishing examination at secondary schools) are not prescribed by a central board or by the ministry, but are set by the teachers themselves, subject only to the approval of the authorities.

The reform in mathematical teaching is only one step in the reorganization of secondary education. This reorganization aims at making the youth of our country sympathetic with labor as well as appreciative of the best that is in modern culture. From this point of view the teaching of mathematics and science assumes a position equivalent to that in history and languages. It has been felt to be an important problem to reorganize the teaching of mathematics and science, and you are doubtless aware that the "Unterrichtskommission" of the German Association for the Advancement of Science, now enlarged to the "Deutscher Ausschuss für den mathematischen und naturwissenschaftlichen Unterricht," has prepared special outlines for the teaching of mathematics and physics as well as for that of biology. In presenting the German reports of the International Commission on the teaching of mathematics, I beg to be allowed to place here upon the table the publications of the Unterrichtskommission[3] and of the Deutscher Ausschuss[4] as far as they have been published until now.

A. Gutzmer

University of Halle

THE NINETEENTH INTERNATIONAL CONGRESS OF AMERICANISTS, 1914

In the fall of 1911 a number of delegates to the past congresses of the Americanists met in Washington, under the auspices of the Smithsonian Institution and the Anthropological Society of Washington, for the purpose of taking preliminary steps toward extending an invitation to the congress at its London meeting, to hold its nineteenth session in 1914 at Washington. A temporary organizing committee was selected, consisting of Professor W. H. Holmes, chairman; Mr. F. W. Hodge; and Dr. A. Hrdlička, secretary. This committee entered into communication with the principal local institutions and organizations which are interested in the work of the Americanists, and by May 1, 1912, a formal invitation to the congress was agreed upon by the Smithsonian Institution, the Anthropological Society of Washington, the George Washington, Georgetown and Catholic universities, and the Washington Society of the Archeological Institute of America. A list of names of persons to form the permanent organizing committee was agreed upon and Dr. Hrdlička was instructed to present the joint invitation with the list just mentioned to the council of the London meeting of the Americanists, which was done, and both were accepted without objection. In addition an official invitation from the Bolivian government was accepted for a second session, to be held at La Paz following that in Washington.

On October 11, 1912, the permanent committee for the Washington session met in the U. S. National Museum for organization. Its membership is as follows: Messrs. Franklin Adams, Frank Baker, Chas. H. Butler, Mitchell Carroll, Charles W. Currier, A. J. Donlon, J. Walter Fewkes, Alice C. Fletcher, Gilbert H. Grosvenor, F. W. Hodge, H. L. Hodgkins, William H. Holmes, Walter Hough, Aleš Hrdlička, Gaillard Hunt, J. F. Jameson, George M. Kober, D. S. Lamb, Chas. H. McCarthy, James Mooney, J. Dudley Morgan, Clarence F. Norment, Thomas J. Shahan, H. J. Shandelle, George R. Stetson, Chas. H. Stockton, J. R. Swanton, Harry Van Dyke, Charles D. Walcott and M. I. Weller.

The elections of officers resulted, in the main, as follows:

For Patron of the Congress: The President of the United States.

[3] A. Gutzmer, "Die Tätigkeit der Unterrichtskommission der Gesellschaft Deutscher Naturforscher und Aerzte," Leipzig, 1908, B. G. Teubner.

[4] "Schriften des Deutschen Ausschusses für den mathematischen und naturwissenschaftlichen Unterricht," Leipzig, Heft 1–14, B. G. Teubner.

President, Organizing Committee: W. H. Holmes, head curator, department of anthropology, U. S. National Museum.

Secretary: A. Hrdlička, curator, division physical anthropology, U. S. National Museum.

Auxiliary Resident Secretaries: Dr. Chas. W. Currier, Mr. F. Neumann.

Treasurer: C. F. Norment, president, The National Bank of Washington.

Head of General (honorary) Committee: Mr. Charles D. Walcott, secretary, Smithsonian Institution.

Head of Committee on Finance: Dr. George M. Kober, dean, Medical Department, Georgetown University.

Head of Committee on Arrangements and Entertainment: Professor Mitchell Carroll, general secretary, Archeological Institute of America.

Head of Committee on Printing and Publication: Mr. F. W. Hodge, ethnologist in charge of the Bureau of American Ethnology.

The sessions of the congress will be held, due to the courtesy of the authorities of the Smithsonian Institution, in the new building of the National Museum. The exact date for the meeting will be decided upon later, in accordance with the wishes of the majority of the delegates to the congress, but the month will, in all probability, be September. Active preparations for the session, which promises to be one of the most important ever held by the Americanists, will be begun without delay.

A. HRDLIČKA,
Secretary Committee of Organization

SCIENTIFIC NOTES AND NEWS

PRESIDENT TAFT has recommended to the congress that Colonel Goethals be appointed major general in the army as a recognition of his executive work in the construction of the Panama canal.

DR. REID HUNT, U. S. Public Health Service, has been appointed a member of the board created by the Bureau of Mines to study the hygiene and dangers in mines.

AT its last meeting the Rumford Committee of the American Academy of Arts and Sciences made the following appropriations: to G. W. Ritchey, of Pasadena, $500 for the construction of a reflecting telescope employing mirrors with new forms of curves; to Professor Edward L. Nichols, of Cornell University, $250 for the construction of a new form of electromagnet, to be used in an investigation by Mr. W. P. Roop, on the effect of temperature on the magnetic susceptibility of gases.

PROFESSOR L. A. CLINTON, who for the past ten years has been director of the Connecticut Agricultural Experiment Station at Storrs, has resigned and accepted a position with the Office of Farm Management of the U. S. Department of Agriculture. Professor Clinton's work with the department will be to have charge of the farm management investigations for the North Atlantic states.

PROFESSOR EDWARD M. FREEMAN, chief of the division of plant pathology and assistant dean and secretary of the faculty of the college of agriculture of the University of Minnesota, has declined the offer of the position of chief pathologist of the Kew Botanical Gardens. The position carries a salary of $4,700.

DR. G. R. KRAUS, professor of botany at Würzburg, has retired from active service.

MR. FRANK MEYER, agricultural explorer for the United States Department of Agriculture, will sail for China where he will conduct botanical exploration in the interior for the next three or four years.

MR. CHAS. WILSON and Mr. Arthur Henn, seniors in Indiana University, will sail on December 21 for Buenaventura, Colombia. They will explore Pacific slope streams and the Atrato river in continuation of the work of Professor C. H. Eigenmann on these streams between January and March of the present year.

THE fifth of the present course of Harvey Society lectures was given at the New York Academy of Medicine on December 14, by Professor F. B. Mallory, Harvard University, on "Infectious Lesions of the Blood Vessels."

PROFESSOR C.-E. A. WINSLOW, of the department of public health of the American Museum of Natural History and of the College of the City of New York, opened the first seminar of a series conducted by the department of biology, Trinity College, on the evening of December 5.

Professor A. P. Carman, head of the department of physics of the University of Illinois, lectured on November 19, before the Central Association of Science Teachers at their meeting at Northwestern University.

At the first meeting for the year of the Oregon Academy of Sciences on November 30, Dr. William T. Foster, president of the academy, gave a brief opening address on "The Scope of the Academy and the Exact Sciences in Daily Life." Dr. Frank L. Griffin, professor of mathematics in Reed College, spoke on "The Ever-present Limit Concept," a discussion of higher mathematics in the common thought of to-day.

The Minnesota chapter of the Sigma Xi held the first of its scientific meetings on November 25. Two researches were presented: "The Enrichment of Sulphide Ores," by Professor William H. Emmons, and "The Scattering of Cathode Rays," by Dr. Louis W. McKeehan.

The Royal Geographical Society is taking steps to celebrate the Livingstone centenary on March 17, when Sir Harry Johnston is to give an address, and it is expected that Sir John Kirk, the only surviving companion of Livingstone on his expedition of 1858–64, will be present. The society is also arranging an exhibition of Livingstone relics, including autograph maps, Livingstone's sextant, compass, etc., with portraits and views and a section of the tree under which Livingstone's heart was buried, with the rude inscription carved by his native followers.

Edwin Smith, connected with the U. S. Coast and Geodetic Survey since 1870, known especially for his work on determinations of the force of gravity, died at Washington on December 2, aged sixty-one years.

Eben Jenks Loomis, for a half century (1850–1900) in the Nautical Almanac Office of the U. S. Navy Department, died on December 2 at Observatory House, Amherst, Mass., aged eighty-five years. Besides his technical work, he was a close student and observer of nature, discovering in 1877 a very remarkable flexing frond-movement of one of the lesser ferns growing about Washington, which at the time excited the keen interest of both Gray and Darwin.

Dr. William A. Buckhout, professor of botany and the senior professor at the Pennsylvania State College, died of heart disease on Tuesday, December 3, 1912. Dr. Buckhout was born in December, 1846, and was graduated from the Pennsylvania State College, in 1868. In 1871 he became professor of botany and horticulture in this college. In the changes brought about in agricultural sciences during recent years he became professor of botany. For many years he was botanist of the Pennsylvania State Board of Agriculture. In 1888 he was appointed to the Pennsylvania State Forestry Commission and was a prime mover in the state in creating and taking an active interest in forestry. He was a fellow of the American Association for the Advancement of Science. He was author of papers such as "The Chestnut as a Fruit and Food," "The Effect of Smoke and Gas on Vegetation," "A Microscopic Examination of State College Water Supply," "Forest Fires," and others, with annual reports as state botanist.

Dr. Edward Curtis, of New York, emeritus professor of materia medica and therapeutics in the College of Physicians and Surgeons of Columbia University, died on November 28, aged seventy-four years.

Dr. Elie de Cyon, formerly professor at the Academy of Sciences of St. Petersburg and the author of important contributions to physiology, has died, aged seventy years. He left Russia for political reasons and settled in Paris, where he devoted himself to literary work.

Mr. William Forsell Kirby, for many years a member of the zoological department of the British Museum (Natural History), the author of many publications on entomology, died on November 20, aged sixty-eight years.

DR. DAVID AXENFELD, professor of physiology at Perugia, has died at the age of sixty-four years.

MEMBERS of Section E, Geology and Geography, of the American Association for the Advancement of Science, are urged to send as soon as possible to Professor G. F. Kay, Iowa City, Iowa, the titles of papers to be read at the Cleveland meeting.

W. CAMERON FORBES, '92, governor-general of the Philippine Islands, has given to the Peabody Museum of American Archeology and Ethnology and to the Museum of Comparative Zoology some important collections of objects which illustrate life on those islands.

MR. AUSTEN CHAMBERLAIN has received £48,000 towards the £100,000 which he is raising for the London School of Tropical Medicine.

THE estimate of expenditure for the Bureau of Mines for the fiscal year beginning July 1, 1913, is as follows: for general expenses, $70,240; for investigating mine accidents, $347,900; for fuel investigations, $135,000; for investigations into the treatment of ores and other mineral substances, $250,000; for inspecting mines in Alaska, $6,500; for books and publications, $2,500; toward the erection of a suitable laboratory for the Bureau of Mines at Pittsburgh, $115,000; for the collection of statistics concerning accidents in the mining industry, etc., $25,000; for the purchase or lease of land for headquarters for mine safety cars, $2,000. A total of $954,140. The increases asked for include $4,140 for general expenses, $27,900 for investigating mine accidents, $200,000 for investigations into the treatment of ores and other mineral substances, $1,000 for the purchase of books and other publications, $115,000 towards a new fire-proof laboratory and $25,000, for the collection of statistics concerning accidents in the mining industry and other interests.

THE interesting region of the Arizona Petrified Forest was surveyed by the United States Geological Survey in 1910, and the resulting map has just been issued. The field work was done by Topographic Engineers Pearson Chapman and J. G. Staack, under the direction of R. B. Marshall, chief geographer. The area covered by this survey is known as the Petrified Forest quadrangle, and the map will be of especial interest and value to visitors to this remarkable region. It includes the principal portions of the Petrified Forest National Monument, a reservation created by executive order to protect these natural wonders against commercial vandalism, which was making serious inroads into the petrified specimens. The map shows the location and topography of six separate forests, including the famous Petrified Natural Bridge. The fossil trees of these forests are hundreds of thousands if not millions of years old, the wood of the trees having been submerged beneath a heavy covering of soil and then silicified and turned to stone. This stone is exceedingly hard; in fact, it is an agate, of many colors—red, yellow, purple, blue and intermediate shades—and is susceptible of a very high polish. The Petrified Forest is just south of the line of the Santa Fe Railway, in Navajo and Apache counties, Ariz., and is reached by wagon road from the town of Adamana. The map is sold by the director of the Geological Survey at a nominal price.

THE surface of the United States is being removed at the rate of thirteen ten-thousandths of an inch a year, or 1 inch in 760 years, according to the United States Geological Survey. Though this amount seems trivial when spread over the surface of the country, it becomes stupendous when considered as a total, for over 270,000,000 tons of dissolved matter and 513,000,000 tons of suspended matter are transported to tidewater every year by the streams of the United States. This total of 783,000,000 tons represents more than 350,000,000 cubic yards of rock substance, or 610,000,000 cubic yards of surface soil. If this erosive action had been concentrated upon the Isthmus of Panama at the time of American occupation, it would have excavated the prism for an 85-foot level canal in about 73 days. The amounts removed from different drainage basins show interesting comparisons. In respect to dissolved matter, the southern Pacific basin heads the list with 177 tons per square mile per year, the northern Atlantic basin being next with 130 tons. The rate for the Hudson Bay basin, 28 tons, is lowest; that for the Colorado and western Gulf of Mexico basins is somewhat higher. The denudation estimates for the southern Atlantic basin correspond very closely to those for the entire United States. The amounts are generally lowest for streams in the arid and semiarid regions, because large areas there contribute little or nothing to the run-off. The southern Pacific basin is an important exception to this general rule, presumably because of the extensive practise of irrigation in that area. The amounts are highest in regions of high rainfall, though usually the waters in those sections are not so highly mineralized as the waters of streams in arid regions.

The first instalment of the vast works planned by Sir W. Willcocks for the irrigation of Mesopotamia by the storage of the Euphrates water is now nearing completion. Details as to the present position of the work, which is being carried out for the Turkish government by the engineering firm of Sir John Jackson, Limited, are quoted in the *Geographical Journal*. The part of the scheme first taken in hand has been the building of the great barrage at Hindieh, with associated works by which the water is to be distributed down the old branch of the river, past the site of Babylon, to Hilla. The barrage is being built to the east of the present bed of the Euphrates, and will be 250 meters long, with thirty-five arches fitted with sluicegates. The piers of these arches are now completed up to the springing of the latter. This barrage will raise the level of the water by 7 meters, while a subsidiary barrage immediately below will provide for a further difference of 2½ meters. Adjoining the upper barrage there will be a lock for the use of the river traffic, while the lower barrage consists of a lock and a huge shelf of masonry. Work has also been begun on the Hilla regulator, a little above the barrage, which will consist of five arches. The excavation for this has been done, and the masonry begun. These works finished, an earthen dam will be thrown across the stream, which will thus be turned into its new bed between the barrage and the regulator. The old branch has been cleared out, and will be properly canalized, while at Habbania an escape is being constructed by which the floodwater will be carried off into the old Babylonian reservoir. It is estimated that 600,000 acres of land will be plentifully irrigated as a result of these works. The operations have involved a vast amount of excavation, concrete work, masonry, pitching, etc., but there has of late been a plentiful supply of local labor.

UNIVERSITY AND EDUCATIONAL NEWS

By the will of Mrs. Harriet D. Brown, who died in Worcester in November, the Worcester Polytechnic Institute receives a fund of some $50,000, the income to be used for scholarships.

Dr. John C. Hemmeter, professor of physiology at the University of Maryland, at the celebration of academic day on November 12 made a gift of $10,000 for the purpose of beginning the endowment of the chair for experimental physiology.

Mrs. A. M. Jones, widow of Professor Tom Jones, of Manchester, surgeon, who died on October 30, left £1,000 to the Victoria University, Manchester, in augmentation of the endowment of the Professor Tom Jones memorial scholarship, and £500 to the University College of Wales, Aberystwith, as an endowment for promoting the study of surgery.

Captain R. W. Silvester, for twenty years president of Maryland Agricultural College, has resigned because of impaired health. He has been made president emeritus and librarian of the institution. Professor Thomas H. Spence, vice-president of the college, has been appointed acting president.

Dr. Herbert J. Webber has resigned from the department of plant breeding of the College of Agriculture of Cornell University, to accept the directorship of the College of Agriculture of the University of California.

Professor C. F. Baker, of the department of biology of Pomona College, has resigned to accept a professorship in the University of the Philippines. He will be at the College of Agriculture, Los Banos, Philippine Islands.

The Coutts Trotter Studentship at Trinity College, Cambridge, founded for the promotion of original research in natural science (especially physiology and experimental physics), has been divided between Mr. E. D. Adrian, B.A., and Mr. A. E. Oxley, B.A.

The council of the University of Paris has elected M. Andoyer, professor of physical astronomy in the faculty of science and member of the council of the Nice Observatory, as successor of the late M. Henri Poincaré in the professorship of mathematical astronomy.

DISCUSSION AND CORRESPONDENCE

INSECTS CONTRIBUTING TO THE CONTROL OF THE CHESTNUT BLIGHT DISEASE [1]

Investigations during the summer of 1912 by the Bureau of Entomology have brought to light some very important relations of insects to the chestnut blight, of which one of the most striking is that certain insects contribute to the natural control of the spread of the disease by feeding on and at the same time destroying the fruiting bodies.

During the winter of 1911 the writer observed many cankers with the pustules eaten out and the diseased bark infested with small larvæ. Later adults of the species were reared from these larvæ, one a Cerambycid, *Leptostylus macula* Say, the other a Colydid, *Synchita fuliginosa* Melsh; both were observed while caged to eat the pustules and stroma, the latter even to eat conidial threads.

At the Forest Insect Field Station 9, Charteroak, Pa., an extensive outbreak of the disease was found where a large percentage of the pustules were eaten. Investigation showed both species to be present but *L. macula* doing most of the work. Other insects collected and caged were found to eat the pustules as follows:

Family Buprestidæ—*Agrilus bilineatus* Web.
Family Chrysomelidæ—*Bassareus pretiosus* Melsh.
Family Trogositidæ—*Thymalus fulgidus* Er.

A number of experiments were made by Mr. R. D. Spencer, of the Chestnut Blight Commission, working with the writer, in culturing the stomach contents and excrement of *L. macula*, but in no case did the spores germinate.

Following these observations, a study of the chestnut throughout its northern range showed the same conditions everywhere the bark disease occurred. In many localities 50 per cent. to 75 per cent. of the pustules were eaten. In some cases scarcely a single perfect pustule could be found on a badly diseased tree and in such localities there was evidence of a marked decrease in new infection.

The fruiting bodies are eaten cleanly and deep into the bark, both pygnida and perithecia being destroyed. During the last summer a perceptible increase in the destruction of the pustules by insects was noticed. This shows that they have acquired a taste for the fungus which points toward increased destruction of the spores.

These insects, though not checking the growth of cankers already formed, play a most important part in controlling the dissemination of the disease.

F. C. Craighead
Branch of Forest Insects,
Bureau of Entomology,
U. S. Department of Agriculture

[1] Read before the Biological Society of Washington, November 16, 1912.

A POSSIBLE CAUSE OF ACCIDENTS TO AVIATORS

To the Editor of Science: I think that your valuable paper is in a position to render a very important service in aiding to lower the death rate among aviators.

Probably if we knew all the causes of disaster we should see that they are of many kinds.

To mention only one of the possible causes, take the gyroscopic effect of the revolving-cylinder motor.

Among your readers there are very many

physicists who collectively have a wealth of knowledge concerning gyroscopic action. Suppose that twenty or more of these were each to write an answer to the following question, suppose that the answers showed substantial agreement, would not their words come with great authority and lead to a thorough investigation of the subject?

The question which I propose for discussion is this:

Is it probable that the gyroscopic action of a revolving-cylinder engine produces dangerous stresses upon the framework of the flying-machine?

Practical airmen are not in agreement in this matter. Some say that the gyroscopic action is negligible, others say the contrary.

If physicists and others who have studied the gyroscope will kindly respond to this suggestion, I will see that marked copies of Science are sent to the editors of the leading aeronautical publications of the world.

James Means

Boston,
November 22, 1912

THE PEDOMETER

To the Editor of Science: In glancing over some pages of the Encyclopedia Britannica (eleventh edition) recently I found a short article on the *pedometer,* the concluding sentence of which is:

> Obviously the pedometer is little better than an ingenious toy, depending even for rough measurements on the uniformity of pace maintained throughout the journey measured.

Two definite statements are here made, both of which are quite erroneous. When properly understood and properly used the pedometer is a most useful addition to the outfit of a traveler and an especially delightful and comforting companion to those who know the joy of seeing the world *à piede.* A cheap instrument (costing only a dollar) which I have carried almost every hour of almost every day during the past dozen years is still "as good as ever," registering distances with an accuracy that is really surprising. It has been tested over hundreds of miles and kilometers of roadway in England, Germany, Italy and Switzerland (especially in the last-named country, where on most highways every kilometer of distance is marked by a stone monument), and found correct generally within one per cent., the error rarely being as much as two per cent. *I have known government surveys not so good.* Such an instrument can hardly be classed with "ingenious toys" and the explanation lies in the fact that the remainder of the sentence quoted above is equally erroneous. With the right sort of pedometer within certain considerable limits the record is *not* affected by variation in length of pace. There are two sorts of pedometers, the right sort and the wrong sort, and unfortunately it is the wrong sort that is usually offered for sale. This is simply a "step counter" the figures on the dial showing the number of steps taken and it is necessary to know the average length of step to convert this record into distance. Aside from the great inconvenience of being obliged to make a calculation whenever one desires to know the distance travelled even this instrument when properly adjusted and calibrated ought to give fairly satisfactory results. But the right sort of pedometer is not a pace counter and the numbers on the dial show directly the distance traversed in miles or, if one has the good fortune to live in a country where reason prevails over prejudice, in kilometers. In this the movement of the registering mechanism is caused by the rise and fall of a kind of horizontal pendulum, the length of the stroke for each step and hence the distance registered being capable of adjustment. But when short steps are taken the pendulum does not pass through the whole arc of its possible movement and the distance registered is consequently less. Thus, as stated above, the movement of the index hand is proportional to the distance traversed and, within certain limits, is not affected by variation in length of step. This is a most important fact and gives to this form of pedometer a value evidently not generally known or appreciated.

T. C. M.

Ravenna, Ohio,
November 11, 1912

SCIENTIFIC BOOKS

The Physiology of Reproduction. By Dr. F. H. A. Marshall. Preface by Professor E. A. Schäfer, and contributions by Dr. W. Cramer and Dr. J. Lochhead. London, New York, Longmans, Green & Co. 1910. Pp. xvii + 706; 154 illustrations. Price $6.00 net.

Some branches of science are extensively intertwined with very many and very diverse branches of other sciences. The physiology of development is a notable example, since the data upon which it rests lie entangled in broad and widely different aspects of zoology and anatomy, obstetrics and gynecology, physiology and agriculture, anthropology and statistics.

Probably it is just this bewildering placement and variety of fact that has hitherto proved so effective a discouragement to authorship in this field. At any rate, the subject is here presented in a complete form for the first time. The physiology of nerve and muscle, of secretion and digestion, have long been systematically studied and the results have been many times brought together; too, studies in practical breeding, gametogenesis, and genetics have long been pursued, and the state of knowledge in each has been frequently epitomized. It is only very recently, however, that physiologists have begun to be impressed with the important relations which processes of reproduction bear to many other life processes; and only in the immediate present, in the field of heredity, is it becoming evident that the physiology of reproduction must help to solve many a problem heretofore attacked only from a very different standpoint. But, the breadth, vigor and thoroughness of Dr. Marshall's pioneering treatise are as satisfactory as the need of such a work was pressing.

Though the author has collected data of many kinds from very many different sources, his volume is much more than a digested abstract of the scattered literature; his own researches during several years on many of the important topics of reproduction have given the insight which alone can produce so unified and clear a volume.

Perhaps the greater number of pages of the work bear mostly upon the morphological side of the subject. This is probably both necessary and advantageous in the present state of the science. A solid structural basis is especially required where and when so many elemental questions are unsolved and still trembling in the balance. Chapters II., III. and IV., dealing with the œstrous cycle and changes in the ovary are notably of this character; largely morphological also are Chapters VII. and X. concerning the accessory reproductive organs of the male, and the placenta. The first chapter treats of the breeding season of animals; all of the invertebrate phyla being considered as well as the several classes of vertebrates. Other important chapters treat of the ovary and testis as organs of internal secretion, changes in the maternal organism during pregnancy, fertilization, lactation, fertility and the determination of sex. A rather too condensed but excellently written chapter on the biochemistry of the sexual organs will be welcomed by many. Besides other things it brings together for the first time most of the data now at hand on the new and promising subject of the energetics of development.

In many of these chapters the data and theories presented are criticized in the light of the author's own researches. In this way are presented some excellent treatments of such subjects as, the internal secretory function of the ovary and the testis; Mendelism; the influence of domestication, feeding, etc., upon the recurrence of the œstrous cycle and upon fecundity; fertility, and ovulation and the ovarian changes. We may note the point of view in only one or two of these cases. The internal secretions of the reproductive organs are attributed a scope and rôle not accorded by some recent investigators; and the connection between the ovary and uterus is considered as exclusively chemical, not nervous. Again, we note that the author is not led by the study of the physiology of reproduction to accept some of the important conceptions of Mendelism. "To the physiologist therefore a so-called unit character can not readily be regarded as something located originally in a chromosome or chromomere. . . . It may be argued, therefore, in criticism of the Mendelian conception of unit characters, that it takes little or no account of the metabolism of the organism as a whole." How great a heresy to proceed from Cambridge! The book is indeed a mine, but the function of the reviewer can not be to extract the ore.

It is pleasing to find the volume dedicated to Mr. Walter Heape, to whom we owe so great a part of what is known of the physiology of the œstrous cycle, as well as much besides that is pertinent to this volume. More pleasing still is the style in which the whole work is written. In reading this volume one never tires, and there is little chance of getting lost. Adequate reference to an enormous literature and a comprehensive index add value to the book.

Dr. Marshall's pioneering treatise brings abundant help and inspiration to investigators within the several divisions of its field, and will ably and authoritatively serve the needs of the practical breeder and gynecologist.

Oscar Riddle

Methods of Organic Analysis. By Henry C. Sherman, Ph.D., Professor of Food Chemistry in Columbia University. Second edition. Rewritten and enlarged. New York, The Macmillan Co. 1912. $2.40 net.

The author has collected in this volume the methods of analysis of the more important organic compounds especially as applied to plant and vegetable substances and their manufactured products. They include such subjects as alcohols, aldehydes, sugars, oils, fats, waxes, soap, milk and preservatives. The best recognized methods have been selected and attention called to precautions necessary to secure satisfactory results.

One who wishes to know the best methods of analysis can not do better than consult this book, as the author has increased its value by adding, at the end of each chapter, a list of reference books and journal references for the past ten years. The use of this book by students would certainly give them practise in a considerable variety of analyses and make them capable of handling any ordinary problem presented.

J. E. G.

A College Text-book on Quantitative Analysis. By H. R. Moody, S.B. (M.I.T.), A.M., Ph.D. (Columbia), Associate Professor of Analytical and Applied Chemistry, College of the City of New York. New York, The Macmillan Co. 1912. 165 pages. $1.25 net.

This book, as the author states, is designed to be used by those who may be taking up quantitative work by themselves or with an instructor whose classes are too large to admit of much individual attention. It contains very explicit directions regarding every detail and is intended to make obvious the unnecessary pitfalls that consume time. For the purpose for which it is designed and for use in a brief course in a high school or college this book should be of great value in training the student in exact methods of procedure; but it seems too mechanical to put in the hands of a graduate student who is making a specialty of chemistry and is approaching the subject in a broad and comprehensive manner.

J. E. G.

Qualitative Organic Analysis. By F. B. Thole, B.Sc. (London), F.C.S., London University Exhibitioner in Chemistry, Lecturer in Organic Chemistry, East Ham Technical College, with an introduction by H. E. Dunstan, D.Sc. (London), Head of the Chemical Department, East Ham Technical College. London, Methuen & Co., Ltd.

In the introduction attention is called to the fact that "no royal road exists for the identification of an organic compound." The aim of this book is to afford a concise treatment of the subject on simple and logical lines, proceeding from the determination of the elements present in each case to the final characterization of the compound. The author has given a description of the common operations in practical organic chemistry, determination of the melting and boiling points and preliminary tests for the elements present, before taking up the identification of the class and individual. These are clearly and concisely stated and should lead to the identification of the more important organic substances, provided the identification is substantiated by the preparation of the substance itself, without which no identification is really satisfactory.

J. E. G.

Notes on Qualitative Analysis. By Horace G. Byers, Professor of Chemistry, University of Washington, and Henry G. Knight, Director of Experiment Station, University of Wyoming. New York, D. Van Nostrand Co. 1912. $1.50 net.

We have here a further addition to the already too numerous volumes on qualitative analysis. The author has devoted, as we find to be the case in most of the recent books on this subject, the first fifty or so pages to a discussion of the physical-chemical principles of the subject before taking up the chemistry of the metals and their separation. The usual methods of analysis are used in most cases and at the end of each chapter questions of a general nature regarding the metals of that group and their compounds are added. One feature of the book which is to be specially commended, owing to the increasing use of special alloys, is the introduction of a chapter on the analysis of materials containing the so-called rare metals.

J. E. G.

Sociology in its Psychological Aspects. By Charles A. Ellwood, Ph.D., Professor of Sociology in the University of Missouri. New York and London, D. Appleton & Co. 1912. Pp. 402.

This is a thoughtful book, based on wide reading and careful scholarship. The large range of subjects with which it deals have all, at one time or another, attracted the serious attention not only of sociologists, but of many psychologists as well. The presentation of these subjects follows a logical order. The first six chapters are largely introductory. They discuss the conceptions, methods and problems of sociology and the relation of sociology to other sciences. Later chapters treat of the origin of society, social coordination, social self-control, the rôle of instinct, feeling, intellect, imitation and sympathy in the social life, the social mind and forms of association. The final topics are entitled social order, progress and the nature of society.

The chief unifying feature of the book is the author's conception of society. Society he defines as a group of individuals carrying on a collective life by means of mental interaction. In consequence the fundamental task of the sociologist becomes the study of the continuously changing coordinations or coadaptations of the activities of the members of groups and of the relations of groups to the environment. Sanctioned modes of coordinated activity become institutions. Systems of government, law, religion, morality and education, however, are not to be understood from the standpoint of any single mental element, such as instinct, imitation, sympathy, feeling, desire or intellect. Nor are they to be understood from the standpoint of any special science, such as geography, ethnology or economics. A synthetic view is necessary.

During the course of the book, Professor Ellwood views this central position from almost every conceivable abstract point of view. The terms society, sociology, the collective life process, the unit of investigation in sociology, social psychology, social coordination, intermental stimulation, instinctive association, social forces, social mind, social consciousness, social will, public opinion, social organization, social control and many others that have appeared in sociological articles or books during the past twenty years, are all defined with great care and considered in detail. The various meanings that have been read into them by those who invented them or who have used them most are discussed. The reader is told in clear language exactly how these meanings differ from each other and from Professor Ellwood's own conceptions.

The value of the work thus accomplished is enhanced by frequent and exact citation of authorities.

Concerning the specific treatment of the large number of topics discussed by Professor Ellwood little can be said in a brief review. Concerning the adequacy of the book as a whole, however, a few words of comment may not be out of place. In the preface Professor Ellwood himself modestly refers to the volume as an introduction to the psychological theory of society. That this correctly characterizes it, however, is true only in the sense that every work that attempts to deal with so large a field must leave the major part of the task undone.

The chief thing, however, which Professor Ellwood leaves undone is to bring abstraction to the test of inductive verification and to make concrete application of theory to history and to current events. To require him to have thus tested and applied all the theories he discusses, however, would be to demand of him the completed results of the task which sociology is just beginning. The fault perhaps lies more with the present status of sociology than with Professor Ellwood. Nevertheless, in the present reviewer's opinion the author could have improved his book very greatly by condensation of abstract discussion, by more frequent appeal to fact and more frequent illustration of the practical value of theory in meeting the broad problems of public policy.

To have systematically reviewed in a single volume, however, the various positions taken by the most important writers on the long list of topics mentioned above is a service; to have done so with the insight and care shown by Professor Ellwood is an achievement.

A. A. Tenney

Columbia University

A VOTE ON THE PRIORITY RULE BY THE AMERICAN SOCIETY OF ZOOLOGISTS, CENTRAL BRANCH

At the April meeting of the Central Branch of the American Society of Zoologists at Urbana, the Committee on Nomenclature in its report to that body requested authority to ask from the membership of the Central Branch an expression of opinion on the following question: "Do you favor the strict (inflexible) application of the 'priority rule' as the latter is now interpreted by the International Commission on Nomenclature?"

This request was granted by the adoption of the report by the Central Branch on April 5, 1912.

The chairman of the committee then entered into correspondence with the other four members in order to reach an agreement as to the manner of taking such a ballot, and this correspondence was terminated just before the commencement season of 1912, too late for a satisfactory ballot to be taken during that collegiate year.

On September 20, 1912, a letter was addressed to each member of the Central Branch showing the authority under which the vote was taken, quoting the "priority rule" without comment and asking a prompt return of the enclosed ballot in an addressed and stamped envelope furnished with the vote.

Practically a month was given for the return of the ballots, and then the chairman of the committee requested the two nearest members to meet with him at Chicago on October 19 to open the ballots and decide on the form and medium of publication of the result of the vote.

The following members voted in favor of the strict (inflexible) application of the priority rule as now interpreted by the International Commission on Nomenclature:

J. F. Abbott, professor of zoology, Washington University.

C. H. Eigenmann, professor of zoology, Indiana University.

Harrison Garman, professor of entomology and zoology, Kentucky State University; and state entomologist.

Harold Heath, professor of invertebrate zoology, Stanford University.

S. J. Holmes, associate professor of zoology, University of California.

W. J. Moenkhaus, professor of physiology, Indiana University.

S. E. Meek, assistant curator of zoology, Field Museum of Natural History.

Wm. E. Ritter, director, Scripps Institution for Biological Research of the University of California; professor of zoology, University of California.

Alexander G. Ruthven, head curator, Museum of Natural History, University of Michigan.

Frank Smith, associate professor of zoology, University of Illinois.

Harry Beal Torrey, professor of biology, Reed College.

S. R. Williams, professor of zoology, Miami University.

Robert H. Wolcott, professor of zoology, University of Nebraska.

The following members voted against the strict (inflexible) application of the priority rule as now interpreted by the International Commission on Nomenclature:

C. R. Bardeen, professor of anatomy, University of Wisconsin.

E. A. Birge, dean, University of Wisconsin.

H. L. Bruner, professor of biology, Butler College.

C. M. Child, associate professor of zoology, University of Chicago.

W. C. Curtis, professor of zoology, University of Missouri.

S. A. Forbes, state entomologist of Illinois.

T. W. Galloway, professor of biology, Millikin University.

John G. Graham, professor of biology, University of Alabama.

M. F. Guyer, professor of zoology, University of Wisconsin.

C. Judson Herrick, professor of neurology, University of Chicago.

Gilbert L. Houser, professor of animal biology, State University of Iowa.

S. J. Hunter, professor of entomology, University of Kansas.

Lynds Jones, associate professor of animal ecology, Oberlin College.

Charles A. Kofoid, professor of zoology, University of California.

F. L. Landacre, professor of zoology and entomology, Ohio State University.

George Lefevre, professor of zoology, University of Missouri.

E. L. Mark, Hersey professor of anatomy and director of zoological laboratory, Harvard University.

Wm. S. Marshall, associate professor of entomology, University of Wisconsin.

C. E. McClung, professor of zoology, University of Pennsylvania.

Maynard M. Metcalf, professor of zoology, Oberlin College.

Henry F. Nachtrieb, professor of animal biology and head of department, University of Minnesota.

H. V. Neal, professor of biology, Knox College.

James A. Nelson, expert in agriculture, Bureau of Entomology.

C. C. Nutting, professor of zoology, State University of Iowa.

J. T. Patterson, adjunct professor of zoology, University of Texas.

Jacob Reighard, professor of zoology, University of Michigan.

Edward L. Rice, professor of zoology, Ohio Wesleyan University.

Oscar Riddle, research associate, Carnegie Institution.

John W. Scott, assistant professor of zoology, Kansas State Agricultural College.

V. E. Shelford, instructor in zoology, University of Chicago.

A. Franklin Shull, assistant professor of zoology, University of Michigan.

George Wagner, assistant professor of zoology, University of Wisconsin.

L. B. Walton, professor of biology, Kenyon College.

Henry B. Ward, professor of zoology, University of Illinois.

S. W. Williston, professor of paleontology, University of Chicago.

The following members returned their ballots unmarked; one of them without comment, and the other two with comments indicating that they declined to vote on the question:

W. J. Baumgartner, assistant professor and chairman of department of zoology, University of Kansas.

J. B. Johnston, professor of comparative neurology, University of Minnesota.

Frank A. Stromsten, assistant professor of animal biology, State University of Iowa.

SUMMARY

In favor of the strict (inflexible) interpretation of the "priority rule"	13
Against the strict (inflexible) interpretation of the "priority rule"	35
Total vote	48

It thus appears that slightly more than 73 per cent. of the members of the Central Branch of the American Society of Zoologists who voted on the priority rule are opposed to the strict (inflexible) application of the rule as now interpreted by the International Commission on Nomenclature.

ANALYSIS OF THE VOTE

The three members of the committee who opened the ballots think it of interest to present the following brief analysis of the vote, based on a division of the voters into classes of voters. The classification of voters is made on the concurrent judgment of the canvassers, and would probably vary somewhat had the selection been made by another committee. It is not likely, however, that the result of the analysis would be materially changed by any one having a somewhat wide acquaintance among the voters.

1st class.—Zoologists that may properly be called non-systematists.

Total number of voters in class	25
Number in favor of priority rule	3
Number opposed to priority rule	22
Majority against rule	88 per cent.

2d class.—Systematists in a broad sense. Including those who have had considerable experience in identifying species and some experieuce in naming and describing new species.

Total number of voters in class	23
Number in favor of priority rule	10
Number opposed to priority rule	13
Majority against rule	56½ per cent.

3d class.—Systematists in a strict sense. Including those who have done monographic work in systematic zoology; work that can be regarded as authoritative in its own field. This class is a selected group from the 2d class.

Total number of voters in class	7
Number in favor of priority rule	3
Number opposed to priority rule	4
Majority against rule	66⅔ per cent.

The number in this class is so small that it would probably be fair to conclude that the systematists in a strict sense are about equally divided in opinion regarding the priority rule.

REMARKS

A space on the ballot headed "Remarks" was utilized by twenty-one of those who voted. An attempt is made below to summarize these remarks:

"Remarks" on Ballots in Favor of Priority Rule

Three voters believed that the adherence to the rule would be best for future generations of zoologists.

One believes "in the establishment of authority by legislation and not in individual judgment."

One considers adherence to the rule "the only way out of the present confusion of tongues."

One, who votes for the rule, says:

> I am strongly in sympathy with what I understand to be the spirit of the "law of priority," but am certain that as it is being applied in the group of organisms with which I am particularly familiar it is producing results exactly the reverse of what, in the spirit of it, it is expected to produce; that is, it is adding to, not diminishing, confusion.

This is one of the voters of the 3d class, as defined above.

"Remarks" on Ballots Opposed to the Priority Rule

There were four who believed that it should be possible for a committee of experts to modify or make exceptions to the rule.

Four believed that names of long standing and general acceptance should be exempted from the application of the priority rule.

Two believed that a more flexible application of the rule would make for greater convenience. One says:

> Nomenclature is a tool, and serves its best purpose when it operates with the greatest convenience. It is certainly not convenient when a name known to everybody as applying definitely to a definite object is changed on the discovery that some long forgotten uame has priority.

Another voter voices practically the same opinion.

One is opposed to the strict application of the rule, but is also opposed to individual action in the matter.

One opposes the rule because "it [opposition to the rule] is the position occupied by practically all of the zoologists of the German Empire."

One votes in the negative because systematists in whom he has confidence complain of the working of the rule.

One, although opposed to the rule, is in favor of "some sound, workable set of rules."

There were two voters who declined to vote because they were not systematists and believed that they should have no voice in the matter.

In summing up it seems evident that an overwhelming majority of the zoologists of the Central Branch are opposed to the strict application of the priority rule; that a clear majority of systematists in a broad sense are opposed to it; and that at least half of the systematists in a strict sense are opposed to it.

The undersigned give it as their personal opinion that the wishes of the non-systematists, users of zoological names, should have *some* weight in the formulation of rules of nomenclature, as they will certainly have *much* weight in the acceptance of names and their incorporation into the general literature of the science of zoology.

C. C. Nutting
S. W. Williston
Henry B. Ward

SPECIAL ARTICLES

FAT DEPOSITION IN THE TESTIS OF THE DOMESTIC FOWL [1]

Various investigators have concluded that the presence of fat in the interstitial tissues of the primary sexual organs (ovary and testis) was evidence of a functional (secretory) activity of the interstitial cells. This view regarding an internal secretion of the testis was advocated by Ganfini.[2] Whitehead,[3] while not committing himself definitely on the point, nevertheless shows that his earlier criticism of Ganfini's theory, on the ground that the fatty substance in the testis had not been shown to be anything other than ordinary neutral fat, was not altogether well taken. Schaeffer[4] makes the presence of fat, as revealed by staining, the chief test of functional interstitial glands in the ovary. One of the present writers in a recent paper from this laboratory[5] has shown that a histological study of the chicken testis gives "no evidence that the fat in the active testis is formed by the interstitial cells." It is further suggested in the same paper that "this fat is being brought to the testis by the general metabolic processes, possibly in connection with sexual activity, just as fat is deposited in the yolk of eggs in the hen."

It seemed desirable to test further, and by direct physiological experiment, this conclusion and suggestion. Particularly information was needed on the following points: (*a*) Is circulating fat deposited in the testis, as it is known to be in the yolk of developing oocytes? (*b*) If so, does such deposition depend in any way upon the functional sexual activity of the organ? (*c*) Is circulating fat deposited in the ovary prior to the time of rapid growth of the oocytes by yolk formation?

To obtain answers to these questions a series of experiments was planned by the writers and carried out last spring. The results are reported in this paper. It is known from the work of Riddle[6] and others that the

[1] Papers from the Biological Laboratory of the Maine Agricultural Experiment Station.

[2] Ganfini, C., "La struttura e lo sviluppo delle cellule interstiziale del testicolo," *Arch. ital. Anat. ed Embriol.*, Vol. I., 1902.

[3] Whitehead, R. H., "A Microchemical Study of the Fatty Bodies in the Interstitial Cells of the Testis," *Anat. Rec.*, Vol. 6, pp. 65–73, 1912.

[4] Schaeffer, Anna, "Vergleichend histologische Untersuchungen über die interstitielle Eierstocksdruse," *Arch. f. Gynäk.*, Bd. 94, pp. (of reprint) 1–51, Taf. XVII.

[5] Boring, A. M., "The Interstitial Cells and the Supposed Internal Secretion of the Chicken Testis," *Biol. Bul.*, Vol. XXIII., pp. 141–153, 1912.

[6] Riddle, O., "On the Formation, Significance and Chemistry of the White and Yellow Yolk of Ova," *Jour. Morph.*, Vol. 22, pp. 455–491, 1911.

fat stain Sudan III., if introduced into an animal *per os,* stains the fatty acids of the food, and that this stain is not lost during the circulation and deposition of these bodies. Furthermore, any fat *already* deposited in the tissues is not stained by Sudan III. fed in this way. This furnishes a method of observing the movement and deposition of fatty acids within the body. The original plan of the present experiments was to feed Sudan III. to chicks of both sexes at regular intervals from the time of hatching on, and then by examination of the testes and ovaries to determine at what stage of development the deposition of fat in the interstitial cells of these organs began, if it occurred at all. It was thought probable *a priori* that the beginning of active deposition would coincide with the beginning of the rapid growth of the sexual organs, which marks the onset of their functional activity.

This was found not to be the case. Experiments were begun with Barred Plymouth Rock chicks of both sexes, taken from the incubator as soon as they had dried off after hatching. To an equal number of individuals of each sex Sudan III. was given in each experiment. The dose was .02 gm. This was enclosed in a very small gelatine capsule, made by cutting down a regular No. 5. The chick's mouth was held open and the capsule carried down into the crop by means of fine forceps. A preliminary lubrication of the capsule in pure glycerine rather aided the administration. One male and one female in each experiment were not fed Sudan III., and these served as controls. In each experiment the total amount of Sudan III. fed was either .02 gm., .04 gm. or .06 gm., the ingestion of the larger amounts being spread over two or three days respectively. The maximum dose given in each twenty-four hours was .02 gm. Twenty-four hours after the ingestion of the last dose the birds were killed and the ovary, or testes, and samples of the body fat were removed and compared with the same organs and tissues taken from the controls. The result was that in all cases there was a distinct pink stain visible in the ovary or the testis of the birds fed the Sudan III. With the very small dose of .02 gm. the stain was faint, but with the large doses much more pronounced. This result shows that even with just-hatched chicks, in which the primary sex organs are certainly in a sexually non-functional condition, fat is being deposited in *both* testis and ovary.

The same result was obtained with chicks one week old. Sudan stained fatty acids were deposited in the primary sex organs. In view of these results there clearly was no point in continuing the experiments at regular intervals up to adult life. Consequently this was not done.

In order to test more fully the novel observation that metabolized fat is deposited in the *testis* an experiment in Sudan III. feeding was carried through with two adult males, one an adult male of the Golden Pencilled Hamburg breed, and the other a cross-bred male. These birds were in full sexual vigor, with large testes. The Sudan III. was fed as follows: The G.P.H. ♂, No. 2,494, was fed one capsule containing Sudan III. on each of four successive days. Each capsule contained .15 gm. of Sudan III. The other bird (No. 2,196) was fed three capsules (one per diem) successively. The amount of stain in each capsule was the same as before. The result of these experiments was exactly as before. There was an abundant deposition of pink stained fat in the interstitial tissue of the testes.

Putting all the facts together the following conclusions would appear to be justified:

1. A part of the metabolized fat from the food is carried directly to the primary sex organs (ovary and testis) and deposited in the interstitial tissues of those organs.

2. The amount of such deposited (and, in the subsequent chemical changes, probably elaborated) fat appears to be sufficient to account for the greater portion if not all of the fat which has been observed by histological methods in the interstitial tissues of the sex organs.

3. The deposition of fat in testis and ovary

as above set forth bears no apparent relation to the functional sexual activity of those organs, since it occurs from the time of hatching on. So far as the available histological or physiological evidence indicates, sexual activation of ovary and testis in the fowl begins at the earliest not until some weeks after hatching.

Raymond Pearl
Alice M. Boring

A NOTE ON THE STAR-NOSED MOLE

To the Editor of Science: On April 20 of this year I discovered a star-nosed mole (*Condylura cristata* (Linn.) Desmarest) entering a half-rotten willow stump at the edge of a little pond in the woods at West Roxbury, Mass. The crevice it had entered proved to be a *cul-de-sac,* and, after watching for some little time its eager efforts to escape by burrowing out, I easily captured it by seizing the tip of the tail between thumb and forefinger. I dropped it on the path close by, where it at once burrowed below the surface of the humus and progressed with some speed there, its progress being indicated by a lengthening ridge of earth. Catching it again, I carried it home wriggling and placed it in a wire cage with a wooden floor. It was very active but, owing, I suppose, to the position of the fore paws, which, of course, were fixed with palms outward, it could not get over the ground very rapidly. In the cage it kept going the rounds, poking its nose between the wires in an effort to escape. I dug some earthworms and placed them one by one in the cage. Apparently the mole's power of scent was nearly or quite as weak as its eyesight, for it paid no attention to the worms unless they were dropped directly in the path it pursued about the edge of the cage. When it actually ran its nose into a worm, however, it ate with astonishing greediness, and in a curiously piggish way, with a constant shaking of the head, and shuffling the worm into its mouth with the help of the *backs* of its "hands," which it moved in unison. It devoured about ten worms before its appetite appeared to flag, but one worm, a very large, fat one, it abandoned after cutting it into three pieces by transverse bites. Perhaps this worm was uncomfortably large for its mouth and gullet, for it afterwards ate one or two smaller ones. Little or no chewing took place, apparently, and the worm always disappeared down the animal's throat in a very short time. I heard no noise of the teeth in eating, such as Audubon and Bachman mention in describing the feeding of the common mole. A saucer of water put inside the cage, was not noticed for some time, but finally the mole put its nose into it and appeared to drink, with the same continual motion of the head that it used in eating. It tipped the saucer up a little and spilled some of the water, which it then seemed to drink off the board in a way that resembled sponging out the bottom of a boat. It continued the same operation on the dry part of the board, as if it could not tell where the water ended except by feeling. It struck me as a creature of very small intelligence. Its eagerness to escape was perhaps due less to fear than to a desire to get below the surface of the ground and to a habit of perpetual motion that seemed to possess it. I use the word "eagerness" advisedly, for that seemed to be the dominant mental attitude of the little animal. There was nothing frantic or nervous about its actions, simply eagerness to enjoy life, liberty and the pursuit of earthworms. The tail, and, in fact, the whole body, was very flexible and had a distinctly sneaky suggestion. This was especially noticeable as the animal climbed up and down the crevice in the stump. The mole escaped the same afternoon, so that my observations on its habits are not extensive, but certain mammalogists to whom I have told the story have advised me to put it on record in the pages of Science.

Francis H. Allen
West Roxbury, Mass.,
May 16, 1912

ECONOMIC IMPORTANCE OF THE MITE PHYLLOCOPTES SCHLECHTENDALI NALEPA

The introduction of this mite into the pear and apple orchards of southern Oregon

(Rogue River Valley) has been comparatively recent. The writer found it for the first time in the summer of 1910, but it was thought to be of slight importance at that time and little attention was given it. Since that time, however, it has been very conspicuous in many pear orchards throughout the valley, and its effect upon the trees was so noticeable this season as to attract general attention.

It is interesting to note that Parrott[1] makes mention of it as very common on apple foliage in the United States, but does not seem to consider it a serious pest. However, he states that "*Epitrimerus pyri* and *Phyllocoptes schlechtendali* have been quite numerous and appear to be more common here than on the continent." However, he adds, "The behavior of these two species in the future is a matter of interest, as both seem to have possibilities of developing to greater economic importance." In Science (N. S., XXIII., 576) he states that *Phyllocoptes schlechtendali* has been detected only on apple foliage. However, the writer has noted that apple foliage is not seriously attacked, while the foliage, terminals of twigs, and frequently the fruits of the pear are most subject to injury. In fact, the presence of the mite on apple foliage seems to be of little importance, as no serious injury because of its presence has ever been observed.

In this district this mite seems to be of economic importance to the pear growers. The injury resulting from its presence in the pear orchards is generally apparent during the latter part of June or early July. The foliage has a peculiar rust or russet appearance on the under side and is also somewhat curled, as though by drought. There may be some slight russeting on the upper side, but this is rather uncommon. The terminals of shoots are also attacked and have the same brownish appearance of the under surface of the foliage. Where the attack is serious, the whole tree has a brownish appearance and the trouble has been given the local name "rusty leaf" by the fruit growers. During the latter part of July and through the month of August, badly injured trees shed the foliage from their terminals. The terminals have a somewhat shriveled appearance, the epidermis being brownish-black or black. Very often the injured epidermis is cracked or broken, due to the expansion of the growing tissue beneath. The fruit is also attacked and is russeted and cracked in the same manner as the terminals.

[1] Bulletin No. 283, New York Agricultural Experiment Station, 1906.

The injury to young pear trees is usually greater than to older bearing ones. Sometimes almost complete defoliation of the young tree results before it has had its season's growth, and besides the epidermis of the growing shoots has been injured. Fortunately, this mite is very easy to control. As in the case of all of our economic species attacking plants, the use of lime-sulphur, dry sulphur, oil emulsions, etc., will completely control it. Since it is a surface feeding mite producing no galls, it would seem that there should be no trouble in eradicating it.

The writer wishes to thank Dr. Nathan Banks, of the U. S. National Museum, for verifying his identification of the species.

P. J. O'Gara

Office of the Pathologist and Entomologist,
Medford, Oregon,
November 4, 1912

A PARAFFIN BATH WITH CONCEALED THERMO-ELECTRIC REGULATOR

One of the disadvantages about the ordinary paraffin bath is the exposed thermo-regulator. By attaching a covered moat to the back and one side of an oblong bath and inserting a thermo-electric regulator similar to one described by Long[1] patterned after Mast[2] there need be no delicate and breakable parts above the bath.

The bath described is heated by two incandescent lamps, one a four-candle, the other a

[1] Long, J. A., "The Living Eggs of Rats and Mice with a Description of Apparatus for Obtaining and Observing Them," Univ. of Cal. Pub. in Zool., Vol. 9, No. 3, pp. 105–136, pls. 13–17.

[2] Mast, S. O., 1907, "A Simple Electric Thermo-regulator," Science, N. S., 26, 554–556.

two. These are lighted constantly. Another four-candle lamp is connected with the regulator. These are placed in an asbestos-lined box beneath the bath. The whole apparatus surrounded with non-conducting material is packed in a box with a hinged cover. The only surface exposed when the box is opened is the top of the bath. Thick pads cover the moat, as it is lower than the top of the bath. This makes it possible to heat eight cups of paraffin, using at the same time less current than would be used by a single sixteen-candle incandescent lamp. Taking out from or putting into the regulator a small drop of mercury makes it possible to either raise or lower the temperature of the bath. Old lamps can be taken out and new ones put in through holes in the bottom of the box.

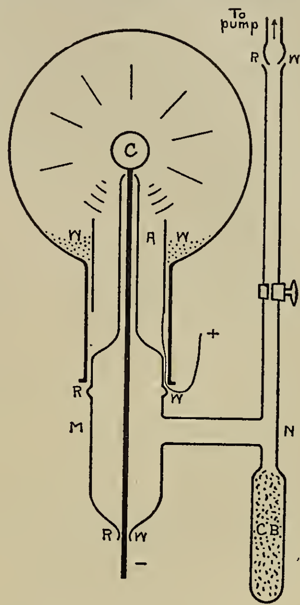
Such a bath has been in use more than a month, maintaining a temperature constant (54° C.) to within a fraction of a degree.

WEBSTER CHESTER
COLBY COLLEGE,
WATERVILLE, ME.

A SIMPLE DISCHARGE TUBE FOR DEMONSTRATION PURPOSES

AT the present time when so much interest is centered on electric discharge phenomena in evacuated tubes it may not be out of place to describe one of the discharge tubes that the writer used recently for class-room demonstration. The experiment is purely qualitative, and in principle contains nothing new. Its aim is to present with simple and easily constructed apparatus some of the phenomena that are usually given with more elaborate and expensive outfits. It does, however, require that the experimenter have access to, and be familiar with, the operation of an ordinary Geissler mercury pump and an induction coil. Aside from these the things needed are found in almost any laboratory and require no more skill to make than the blowing of a glass Tee.

The discharge tube in question is shown in the figure. The bulb may well be a two- or three-liter florence flask. The part to be blown is *MN*. It supports the aluminum rod carrying at its upper end the spherical or oblong cathode, *C*, of the same metal. The anode, *A*, is a cylinder of not too light weight



aluminum foil placed in the neck of the flask as shown. Connection to this is made by a fine copper wire led out through the wax joint, *RW*, at the mouth of the flask. The exhaust tube should contain a glass valve and terminate in a sort of ball and socket joint (to be sealed with wax) so that the apparatus may be readily disconnected from the pump. The charcoal bulb, *CB*, may be dispensed with where liquid air is not available. Liquid air is not a necessity; its use, as is well known, is to hasten the exhaustion. The three joints, *RW*, may be closed sufficiently air-tight by a good grade of red sealing wax.

The various steps, as the exhaustion proceeds, may be vividly shown—the stringy discharge, the Geissler stage, the formation of striæ, the Faraday dark space followed by

Crookes dark space, and finally the formation of cathode and X-rays. The phosphorescence due to the latter is strikingly shown by introducing into the bulb a few cubic centimeters of willemite flour (*W* in the figure). This should be well dusted over the inner surface of the bulb before sealing the apparatus to the pump. A particularly beautiful effect, at the cathode-ray stage, is to disconnect the pump and then shake the bulb vigorously so as to throw the flour through space while the discharge is passing.

Pressure in Mm. Hg	Induction Coil Discharge	Minimum D.C. in Volts Required to Glow Tube	Maximum D.C. Available Was 1,000 Volts	Remarks
2.0	Passed freely.	480	The dischage in each case was more voluminous than with the induction coil.	Blue at cathode.
1.5	More freely.	440		" " "
.5	Still more freely.	360		" " "
.08	Same.	360		Willemite began to phosphoresce.
.01	Less freely.	500	Discharge same as induction coil.	Willemite a beautiful green.
.006	Still less freely.	560	Less than induction coil.	Weaker.
.005	Small.	680	Much less than induction coil.	Still weaker.
.004	Faint.	——	No discharge.	Ceased to phosphoresce.
.003	None.	——	——	——

It may be of interest to add that the tube works well on direct current of fairly low voltage. For that purpose ordinary high potential storage cells (of capacity one tenth ampere normal discharge rate) may be employed. To guard against too great a current flowing through the discharge tube an adjustable water resistance should be included in the storage-battery discharge circuit. The effect upon the ease with which the storage battery discharge passes through the tube may be nicely shown by first ionizing the remaining gases in the tube by means of the high potential induction coil discharge, and then switching instantly to the storage cells. The minimum direct-current voltage that will, for a given pressure, produce a discharge may thus be obtained. This minimum voltage together with other data and remarks are given in the accompanying table.

Chas. T. Knipp

Laboratory of Physics,
University of Illinois

THE CONVOCATION WEEK MEETINGS OF SCIENTIFIC SOCIETIES

The American Association for the Advancement of Science and the national scientific societies named below will meet at Cleveland, Ohio, during convocation week, beginning on December 30, 1912.

American Association for the Advancement of Science.—President, Professor Edward C. Pickering, Harvard College Observatory; retiring president, Professor Charles E. Bessey, University of Nebraska; permanent secretary, Dr. L. O. Howard, Smithsonian Institution, Washington, D. C.; general secretary, Professor H. E. Summers, State College, Ames, Ia.; secretary of the council, Professor H. W. Springsteen, Western Reserve University, Cleveland, Ohio.

Section A—Mathematics and Astronomy.—Vice-president, Professor E. B. Van Vleck, University of Wisconsin; secretary, Professor George A. Miller, University of Illinois, Urbana, Ill.

Section B—Physics.—Vice-president, Professor Arthur Gordon Webster, Clark University; secretary, Dr. W. J. Humphreys, Mount Weather, Va.

Section C—Chemistry.—Vice-president, Professor W. Lash Miller, University of Toronto; secretary, Professor C. H. Herty, University of North Carolina, Chapel Hill, N. C.

Section D—Mechanical Science and Engineering.—Vice-president, Dr. J. A. Holmes, U. S. Reclamation Service; secretary, G. W. Bissell, Michigan Agricultural College, East Lansing, Mich.

Section E—Geology and Geography.—Vice-president, Professor James E. Todd, University of Kansas; secretary, Professor George F. Kay, University of Iowa.

Section F—Zoology.—Vice-president, Professor William A. Locy, Northwestern University; secretary, Professor Maurice A. Bigelow, Teachers College, Columbia University, New York City.

Section G—Botany.—Vice-president, Professor D. S. Johnson, The Johns Hopkins University;

secretary, Professor Henry G. Cowles, University of Chicago, Chicago, Ill.

Section H—Anthropology and Psychology.—Vice-president, Dr. J. Walter Fewkes, Bureau of American Ethnology; secretary, Professor George Grant MacCurdy, Yale University, New Haven, Conn.

Section I—Social and Economic Science.—Vice-president, John Hays Hammond, New York City; secretary, Seymour C. Loomis, 69 Church St., New Haven, Conn.

Section K—Physiology and Experimental Medicine.—Vice-president, Professor J. J. McCleod, Western Reserve University; secretary, Professor George T. Kemp, 8 West 25th St., Baltimore, Md.

Section L—Education.—Vice-president, Professor J. McKeen Cattell, Columbia University; secretary, Professor C. Riborg Mann, University of Chicago, Chicago, Ill.

The Astronomical and Astrophysical Socicty of America.—December 30–January 4. President, Professor E. C. Pickering, Harvard College Observatory; secretary, Professor Philip Fox, Dearborn Observatory, Evanston, Ill.

The American Mathematical Society.—December 31–January 2. President, Professor H. B. Fine, Princeton University; secretary, Professor F. N. Cole, 501 West 116th Street, New York City.

The American Federation of Teachers of the Mathematical and the Natural Sciences.—Between December 30–January 4. President, Professor C. R. Mann, University of Chicago; secretary, Eugene Randolph Smith, The Park School, Baltimore, Md.

The American Physical Society.—President, Professor W. F. Magie, Princeton University; secretary, Professor Ernest Merritt, Cornell University, Ithaca, N. Y.

The American Society of Biological Chemists.—December 30–January 1. President, Professor A. B. Macallum, University of Toronto; secretary, Professor A. N. Richards, University of Pennsylvania, Philadelphia, Pa.

The American Physiological Society.—December 30–January 1. President, Dr. S. J. Meltzer, Rockefeller Institute for Medical Research, New York City; secretary, Professor A. J. Carlson, University of Chicago, Chicago, Ill.

The Society for Pharmacology and Experimental Therapeutics.—December 30–31. President, Professor John J. Abel, The Johns Hopkins University; secretary, Dr. John Auer, Rockefeller Institute for Medical Research, New York City.

The American Society of Naturalists.—January 2. President, Professor E. G. Conklin, Princeton University; secretary, Professor A. L. Treadwell, Vassar College, Poughkeepsie, N. Y.

The American Society of Zoologists.—December 30–January 1. *Eastern Branch:* President, Dr. A. G. Meyer, Tortugas, Fla.; secretary, Professor J. H. Gerould, Dartmouth College. *Central Branch* (in charge of meeting): president, Professor H. B. Ward, University of Nebraska; secretary, Professor W. C. Curtis, University of Missouri, Columbia, Mo.

The Association of American Anatomists.—December 31–January 2. President, Professor Ross G. Harrison, Yale University; secretary, Professor G. Carl Huber, 1330 Hill Street, Ann Arbor, Mich.

The Entomological Society of America.—December 31–January 1. President, Professor Stephen A. Forbes, University of Illinois; secretary, Professor Alexander D. MacGillivray, 603 West Michigan Ave., Urbana, Ill.

The American Association of Economic Entomologists.—January 1–3. President, W. D. Hunter, Dallas, Tex.; secretary, A. F. Burgess, Melrose Highlands, Mass.

The American Microscopical Society.—December 31–January 1. President, Dr. F. D. Heald, Philadelphia; secretary, T. W. Galloway, Millikin University, Decatur, Ill.

The Botanical Society of America.—December 31–January 3. President, Professor L. R. Jones, University of Wisconsin; secretary, Dr. George T. Moore, Botanical Garden, St. Louis, Mo.

Botanists of the Central States.—Between December 30 and January 4. President, Professor T. H. Macbride, University of Iowa; secretary, Professor Henry C. Cowles, University of Chicago, Chicago, Ill.

The American Phytopathological Society.—December 31–January 3. President, Dr. G. P. Clinton, New Haven Agricultural Experiment Station; secretary, Dr. C. L. Shear, Department of Agriculture, Washington, D. C.

The American Nature-Study Society.—December 30–31. President, Professor Benjamin M. Davis, Miami University; secretary, Dr. Elliot R. Downing, University of Chicago, Chicago, Ill.

The Association of Official Seed Analysts.—January 2. President, Dr. E. H. Jenkins, New Haven, Conn.; secretary, E. Brown, U. S. Department of Agriculture, Washington, D. C.

American Association of Official Horticultural Inspectors.—January 2–3. President, Dr. T. J. Headley, New Brunswick, N. J.; secretary, T. B. Symons, College Park, Md.

The American Anthropological Association.—December 30–January 3. President, Dr. J. Walter Fewkes, Bureau of Ethnology; secretary, Professor George Grant MacCurdy, Yale University, New Haven, Conn.

The American Folk-Lore Society.—January 1. President, John A. Lomax, University of Texas; secretary, Dr. Charles Peabody, Peabody Museum, Cambridge, Mass.

The American Psychological Association.—December 30–January 1. President, Professor Edward L. Thorndike, Columbia University; secretary, W. Van Dyke Bingham, Dartmouth College, Hanover, N. H.

The Sigma Xi Convention.—January 2. President, Professor Henry T. Eddy, University of Minnesota; secretary, Dr. Dayton C. Miller, Case School of Applied Science, Cleveland, Ohio.

Gamma Alpha Graduate Scientific Fraternity.—December 31. President, Professor William Crocker, University of Chicago; secretary, Professor H. E. Howe, Randolph-Macon College, Ashland, Va.

NEW HAVEN

The Geological Society of America.—December 28–31. President, Professor H. L. Fairchild, Rochester University; secretary, Dr. Edmund Otis Hovey, American Museum of Natural History, New York City.

The Association of American Geographers.—December 27–30. President, Professor Rollin D. Salisbury, University of Chicago; secretary, Professor Albert Perry Brigham, Hamilton, N. Y.

The Paleontological Society.—December 30–31. President, David White, U. S. Geological Survey; secretary, Dr. R. S. Bassler, U. S. National Museum, Washington, D. C.

BOSTON

The American Economic Association.—December 27–31. President, Professor Frank A. Fetter, Princeton University; secretary, Professor T. N. Carver, Harvard University, Cambridge, Mass.

The American Statistical Association.—December 27–30. President, Professor Walter F. Willcox, Cornell University; secretary, Carroll W. Doten, 491 Boylston Street, Boston, Mass.

The American Sociological Society.—December 27–31. President, Professor Albion W. Small, University of Chicago; secretary, Scott E. W. Bedford, University of Chicago, Chicago, Ill.

The American Association for Labor Legislation.—December 27–28. President, Professor Henry R. Seager, Columbia University; secretary, Dr. John B. Andrews, 131 East 23d St., New York City.

The American Home Economics Association.—December 30–31. President, Miss Isabel Bevier, University of Illinois; secretary, Benjamin R. Andrews, Teachers College, Columbia University, New York City.

NEW YORK CITY

The Society of American Bacteriologists.—December 31–January 2. President, Dr. Wm. H. Park, New York City; secretary, Charles E. Marshall, Amherst, Mass.

SOCIETIES AND ACADEMIES

PHILOSOPHICAL SOCIETY, UNIVERSITY OF VIRGINIA MATHEMATICAL AND SCIENTIFIC SECTION

The second meeting of the session 1912–13 of the Mathematical and Scientific Section was held October 22, 8:00 P.M.

Professor F. P. Dunnington read a paper on "The Grinding of Cornmeal for Bread." Professor Dunnington also made a report of Professor H. A. Bernthsen's method of making ammonia.

Dr. Graham Edgar presented reviews of Professor Samuel Eyde's paper on "The Oxidation of Atmospheric Nitrogen and the Development of Resulting Industries in Norway," and of Professor W. M. Perkin's paper on "Synthetic Rubber."

Wm. A. Kepner,
Secretary

University of Virginia

THE ELISHA MITCHELL SCIENTIFIC SOCIETY

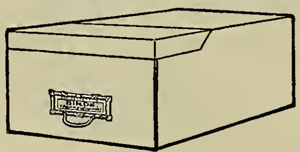
At the 201st meeting of the society held November 12 in Chemistry Hall, University of North Carolina, the following papers were presented:

"The Physiological Action of Hæmatin," by Dr. W. H. Brown.

"Forestry for Eastern North Carolina Lumbermen," by Mr. J. S. Holmes.

James M. Bell,
Recording Secretary

Chapel Hill, N. C.



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BRONX PARK, NEW YORK CITY

SCIENCE

Friday, December 20, 1912

CONTENTS

MSS. intended for publication and books, etc., intended for review should be sent to Professor J. McKeen Cattell, Garrison-on-Hudson, N. Y.

ACADEMIC EFFICIENCY[1]

About ten years ago I was asked by the president and general manager of a large manufacturing corporation to advise him how to improve the performance of his boiler house. During the previous winter it was pushed to its utmost to deliver enough steam to run the engines and to keep the buildings warm, and the next winter, on account of extensions to the factory and increased output, the demand for steam would be still greater. Before beginning my work the president told me something of the history of the company, and of how he came to be the general manager. It had grown in fifty years from a small concern to a large one, occupying several blocks of ground. The business was the manufacture of a variety of shelf hardware. He had for several years been a director and the manager of the sales department, and on the death of the former factory manager the directors insisted on his taking the place, although, as he said, he knew nothing about running a factory. He started in to learn how by calling in the best outside expert advice available. He was paying $10,000 for a year's services of a highly skilled expert in machinery, jigs and methods of manufacturing, who was making a revolution in the shop, which amply justified the high price paid for his services. This man said he knew nothing about boilers, and therefore I was called in to tackle the boiler problem. Incidentally the president told me that the catalogue of the products made by the concern con-

[1] A paper presented at the Boston meeting of the Society for the Promotion of Engineering Education, June 28, 1912.

tained 14,000 items, each of which involved patterns, jigs, templates, storage, bookkeeping records and correspondence. Probably half of these items were either obsolete or in very small demand, and another large fraction were unprofitable to handle. Another $10,000 might have been properly spent in making a selection of which of the 14,000 items should be abandoned and in printing a new catalogue.

In regard to the boilers, the president told me I could get all information available from two men, the superintendent of the factory and the chief engineer, who were at loggerheads. One had told the president one story about the boilers, and the other an opposite story, and he did not know which one to believe. He called the superintendent into the office to tell me his story and, dismissing him, called in the engineer, who told me the other story. I then had the engineer take me through the whole factory, including the power plant. On my return to the office I told the president that the engineer had told the facts, and that the superintendent had not because he was ignorant; he knew nothing about a power plant and never would know, for his bump of conceit was too great to permit of his learning. I reported further that the trouble from lack of steam was not the fault of the boilers—there were about 25 of them, crowding the boiler house to its capacity, and there was no available land for an addition to it—they were making as much steam as they should be called on to make with due regards to economy of fuel; but the trouble was entirely owing to the great waste of steam throughout the factory in winter time. Live steam was used for heating, and numerous traps were wasting both steam and hot water. As a result of my investigation an exhaust-steam heating system was installed, and that stopped all complaints of the insufficient supply of steam.

This long story about a factory may seem to have nothing to do with academic efficiency, but there are several points of resemblance between its condition and that of some educational establishments. They, like it, are suffering from inefficient management continued through a long period of years; they have too many items in their catalogue; heads of departments at loggerheads; a board of directors who are capitalists, but who know nothing of the details of the business they are supposed to direct; a president and general manager who is well versed in the advertising part of the business, but knows nothing of the best ways of producing its product. The factory, however, has two points of difference from and advantage over the college. (1) The competition of its rivals forces it to improve its methods, while the college has no such stimulus to improvement. (2) The manager of the factory referred to knows that he knows nothing about the best way of running a factory and therefore calls in outside expert assistance, the manager of the college thinks he knows it all, and therefore has no need of advice.

I said some educational establishments, not all. There are others, and this brings me to another story. It is about a university.

A certain large university more than twenty-five years ago had an engineering college that was already suffering from dry rot although it was only about ten years old. It had a good location, excellent buildings and equipment, and ample funds, yet the college had lost prestige, and the number of students was decreasing. The president of the university knew nothing about engineering education, but he was wise enough not to pretend to know anything about it. He asked half a dozen or more consulting engineers and engineering professors to visit the college and independently to give him written reports as to what ought to be done to improve the college. I was one of the visitors. I found that the college was divided into two independent departments, one theoretical and the other practical, each presided over by a professor who was responsible only to the president. I spent a morning with one of these professors and an afternoon with the other. Each told a tale of woe, about the utter worthlessness and total depravity of the other man. I advised the dismissal of both, and the appointment of a man who was big enough to be the head of the whole college. Some months were spent by the president of the university in getting these reports and in interviewing different experts, including men whose names had been suggested as qualified for the position. He selected the right man, gave him full authority, approved his every request, and the trustees gave him everything he asked for in the way of competent assistants and additional equipment. The theoretical professor resigned, and the practical one gracefully subsided into a minor subordinate position, where he gave no trouble. The college grew with great rapidity. In ten years it was in the front rank of the engineering colleges of the world, which position it still holds.

Note the points of similarity between the factory and the university as related in these two stories. Each was suffering from inefficient management, each had a president who was ignorant of the details of the business, but who was conscious of his ignorance and was willing to take advice from outside. In each case the advice was taken, with the best possible results.

My subject is entitled Academic Efficiency. I use this short term merely because it has been used before to mean the efficiency of educational methods, and it may be necessary to explain that the word academic here means relating to an academy or educational establishment, and not, as it sometimes means, "unreal" or "unpractical." The word efficiency is often used with different meanings. Dr. Eliot, ex-president of Harvard University, in his little book on "Education for Efficiency" defines it as "effective power for work and service during a healthy and active life" and he says:

> National education will be effective in proportion as it secures in the masses the development of this power and its application in infinitely various forms to the national industries and the national service.

The engineer uses a more restricted and technical definition, the quotient of output divided by input, or the relation or ratio of the result achieved to the effort in obtaining it. Mr. Harrington Emerson objects to this definition as insufficient in its not including an equitable standard of achievement or output as one of its factors, and defines efficiency as the "relation between an equitable standard and an actual achievement," or "the relation between what is and what could be."

Strictly speaking, the engineer's definition is limited to cases in which both the input and the output may be measured in the same unit, or in units that are convertible one into the other, such as foot-pounds and heat-units, but it is a convenient definition for many cases in which neither the whole output nor the whole input is capable of accurate measurement in similar terms. For example:

We spend or give (Input)	We get or gain (Output)
Time	Money or salable goods
Money or raw material	Health
Physical labor	Recreation
Mental labor	Education
Nervous energy	Satisfaction
Health	
Wear and tear of machinery	

If we take the engineers' definition expanded in this way so as to include in the input every conceivable kind of expenditure and in the output every conceivable kind of achievement, it will apply to every activity of man. The efficiency, while it can not be stated in figures, as a percentage, is measured by the value of the output in relation to the input or expenditure. Thus a business man may spend every one of the items listed under the head of input, and measured by a money standard the result may show a high efficiency, but measured by a broader standard, in which the result as to health is a negative quantity, it is most inefficient. Then if he takes to golf playing he may spend time, money and physical labor, and gain health; the efficiency by the money standard is zero, but by the broader standard, including health, recreation and satisfaction, he may consider that the efficiency of the operation is 100 per cent.

A college spends all the items listed under "input," its efficiency is zero from the money standard, for its business is not to make money, and may be high or low measured in the other items listed under output. By Mr. Emerson's definition, the relation of an equitable standard to the actual achievement, or the relation between what is and what could be, we compare the actual output in health, recreation, education and satisfaction, with what might be realized under the best possible conditions of system and management. Are the results what they ought to be in kind, in quality or in quantity, and if they are not, what are the defects and how can they be remedied?

In the big factory of which the story has been told, the product included 14,000 items, many of which should have been abandoned, and much of the inefficiency was due to the factory's making products that should not have been made. When an efficiency expert begins his operations in a factory his first questions are what kind of product is made? Why is it made. Why not abandon it if it is not profitable? The same questions might be asked of a college. The next set of questions covers the quality. Is the quality too highly refined and too costly, so that its market is limited? Is it too common and cheap, so that it has to be brought into competition with the poorest goods on the market? Is it out of date and unfashionable? Is the quality what it ought to be, and if not what are the reasons, and how can it be improved? Surely these questions may be asked of a college, and it is the general belief that the answers would not be complimentary to the college. There are serious defects in the quality of the college product.

Next come questions as to quantity. Is the factory turning out too much of one kind of goods, so that the market is glutted and the price too low? Is it turning out too little, so that it is not doing as much business as it might do? Is it turning out too much of one kind and not enough of another; and if so, what changes should be made so as to establish a proper balance? Is the college overcrowding the professions with men who are not needed in them? Is it failing to supply the demand for the kind of men who are needed? The common opinion is that both of these questions must be answered in the affirmative. The last report of the Carnegie Foundation for the Advancement of Teaching says:

> In almost every state of the union there are more colleges in name than the country needs or can afford. They have been started without much regard to the ultimate educational demands—weak and often superfluous colleges. In many cases their existence makes impossible that of good high schools which would far better serve the educational interests of the community.

After these questions of kind, quality and quantity of product are considered, then comes the question of cost per unit of product and of possible methods of reducing that cost. In the factory the solution of these questions is one of great difficulty and complexity. It includes the items of location, buildings, machinery, system of organization, functional foremanship, statistics, accounting, planning of work, routing it through the shop, methods of payment of wages, keeping high-priced men only on high-priced work and finally time study resolved into its elements, that is, motion-study. I quote from Frank B. Gilbreth's new book on Motion Study:

> There is no waste of any kind in the world that equals the waste from needless, ill-directed and ineffective motions. . . . Tremendous savings are possible in the work of everybody—they are not for one class, they are not for the trades only; they are for the offices, the schools, the colleges, the stores, the household and the farms. . . . It is obvious that these improvements must and will come in time. But there is inestimable loss in every hour of delay. The waste of energy of the workers in the industries to-day is pitiful. . . . In the meantime, while we are waiting for the politicians and educators to realize the importance of this subject and to create the bureaus and societies to undertake and complete the work, we need not be idle. There is work in abundance to be done. Motion study must be applied to all the industries. Our trade schools and engineering colleges can:
>
> 1. Observe the best work of the best workers.
> 2. Photograph the methods used.
> 3. Record the methods used.
> 4. Record outputs.
> 5. Record costs.
> 6. Deduce laws.
> 7. Establish laboratories "for trying out laws."
> 8. Embody laws in instructions.
> 9. Publish bulletins.
> 10. Cooperate to spread results and to train the rising generation.

Mr. Gilbreth refers to motion study of the industries that are producing material wealth, but his words may be applied to the industry of educating men and women, that is, to the schools and colleges.

The methods of reducing the cost per unit of product in industrial concerns have now been reduced to a science by the management experts, Taylor, Gantt, Emerson, Parkhurst and others. In educational circles only the merest beginning has been made. Bulletin No. 5 of the Carnegie Foundation for the Advancement of Teaching, a quarto pamphlet of 134 pages, entitled "Academic and Industrial Efficiency," contains a report by Morris Llewellyn Cooke of the investigation of the department of physics of eight different colleges or universities. Mr. Cooke has had several years' experience as expert on management of industrial works, and is now Director of Public Works of the city of Philadelphia. His report is only a preliminary one, and covers little more than a statistical investigation of the cost of instruction in physics per student-hour, and some observations on methods of administration, and on the economical use of buildings and of the time of the professors and instructors, in all of which he found great differences. The total cost of physics per student-hour at Harvard was $1.08 and at Wisconsin $0.60. Of these totals the interest on plant and equipment and administrative expense account is $0.53 at Harvard, and $0.18 at Wisconsin. There are differences in the colleges which are far more important, however, than those that can be expressed in dollars and cents. For example, Mr. Cooke found one in which the professors showed the heartiest interest in the progress of each individual student, and another in which "every time the students were mentioned, there were evidences that the teachers had in mind the students' scholarly inferiority and waywardness."

The cost per student-hour for any subject may be obtained as in Mr. Cooke's investigation. It will be a far larger task to determine the efficiency of the student-hour —that is, what return in valuable education the student gets for the expenditure of the thousands of student-hours that he spends in college. We have as yet no standards of measurement by which educational efficiency can be satisfactorily measured, but it can not be doubted that some day such standards will be found, when well-qualified experts are employed to find them. For a method of obtaining such a standard in English composition, see the writer's paper in *Proceedings of the Society for the Promotion of Engineering Education* in 1907 on "An Experiment in Teaching English to Freshmen in a University."

Efficiency, according to the engineers' definition, is the relation of output to input, or the relation of the result to the effort and cost expended in achieving it. From the college student's standpoint, the input is four years of time and say $2,000 to $4,000 in money. The output is what he receives for that amount of time and money. Let us put what he receives in tabular form under two heads, life and study.

- Life
  - Acquaintance.
  - Companionship.
  - Fraternity.
  - Social activity.
  - Athletics.
  - Reading.
  - Leisure.
  - Travel.
  - Moral uplift.
- Study
  - Cultural
    - Disciplinary.
    - Information.
  - Technical
    - Foundations of Science and Art.
  - Vocational
    - Relating directly to life work.
  - Curious
    - Non-useful or dilettante.

How many hours out of the 24 in a day are student-hours, and how many are devoted to so-called college life? Is his time properly divided between the activities of life and study? Of the student-hours is there the proper balance between the cultural and the other branches? How and by whom is this balance determined? Which of the courses are prescribed and which are elective, and why? What text-books are used, and why? Are particular courses taught by the text-book and recitation methods, by the lecture and notebook method, by the problem method, or by the laboratory method? Is each teacher free to use his own method or is the method determined on by a department head or committee or by other authority? What experimental pedagogical work has been done to discover the relative efficiency of different methods? What are the results of such experiments? Have they been reduced to statistical form and published? What is the administration doing to improve educational efficiency? Is there any method employed to measure the relative efficiency of different teachers, or of the same teacher in different years or when using different methods? How are the tenures of office, promotion, salary, etc., determined? How are poor teachers got rid of or transferred to other positions in which they may be more efficient. What is the organization of the college, and what are the efficiencies of the board of trustees, the president, and the heads of departments? If an investigator like Mr. Cooke, or preferably a commission of investigators, were to report to the Carnegie Foundation answers to these questions after a year's examination of a dozen or more institutions of learning, it is safe to say that an appalling lack of efficiency would be disclosed. The commission would find every grade of goodness and of badness in the teaching staff, teachers generally overworked, underpaid and dissatisfied and on the lookout for positions elsewhere. It would find self-perpetuating boards of trustees responsible to nobody, individual trustees chosen not for any educational qualification, but solely because they are men of wealth and influence; presidents chosen through personal or political favoritism, whose ideas of education are those of the middle ages, and whose methods of government are those of the tyrant. It would find the conditions mentioned by President Benton, of the University of Vermont, in his inaugural address, 1911, the election of new members of the faculty dependent entirely on the dictum of the president, "the administrative office a veritable cesspool where unpleasant experiences are deposited," "a coterie of professors painfully sycophantic in the presence of their lord and master and bitterly denunciatory of him when left to themselves," "reprehensible hypocrisy by those who teach," etc. President Benton seems to be unaware of the fact that the sycophancy and hypocrisy which he thus bewails are the inevitable results of government by an ignorant despot, and that they can be done away with only by a radical change in the system of government. I do not wish to be understood as believing that the conditions thus described are universal. There are many institutions in which there is no autocratic government, and in which the government approaches in some respect to democratic ideals, where free speech is possible, where merit is recognized and rewarded, and where the teaching methods are constantly being improved. Here and there we find evidences of attempts to find the best methods, and of new experiments in education whose results are very promising, for example, Professor Franklin's improvement at Lehigh in the method of teaching laboratory physics, the examination of the English teaching in different technical schools by Professor Earle of Tufts College, the introduction of the preceptorial system at Princeton, Professor Schneider's cooperative system in Cincinnati, the university extension work at Wisconsin, the investigation by a committee of the Society of American Bacteriologists of the teaching of microbiology, and Dr. Rumely's experimental preparatory school at Interlaken, Ind.

Mr. Harrington Emerson has written a book entitled "The Twelve Principles of Efficiency." He wrote it with especial reference to the efficiency of manufacturing establishments, but the principles may be applied to educational institutions. They are the following: (1) Clearly defined ideals. (2) Common sense. (3) Competent counsel. (4) Discipline. (5) The fair deal. (6) Reliable, immediate and exact records. (7) Despatching. (8) Standards and schedules. (9) Standardized conditions. (10) Standardized operations. (11) Written standard practise instructions. (12) Efficiency reward. The investigating committee might use this list of twelve principles of efficiency in its examination of the colleges and find to what extent they are in operation.

Suppose that the Carnegie Foundation were to have an investigation made such as is here suggested, what good would it do? The same good that Mr. Cooke's investigation of the cost of the student-hour did, and something more. It would call public attention to the subject, and might lead some universities to reform some of their methods. It would reveal how bad things are, which is the first step toward reform. The report would be denounced as Mr. Cooke's has been, by college presidents and by editorial writers of conservative ways of thinking, as utterly subversive of all the ancient educational ideals, and involving "a gross and fundamental error." But it would set men thinking. It would show them that some universities and colleges and some educational methods are better than others, and give the public some knowledge which would enable them to select the best colleges, and some educators of a progressive turn of mind the information they are looking for in regard to methods.

The best possible result of such a report, however, might be that it might induce some multi-millionaire to think that he had a duty to perform in helping to improve the efficiency of educational methods, by contributing the funds that would be required to carry on an educational experiment similar in extent to the experiments carried on by Mr. F. W. Taylor in the Midvale and Bethlehem Steel Works. It required more than twenty years of labor and the expenditure of some hundreds of thousands of dollars to carry on his experiments on tool steel, which have revolutionized machine-shop practise, and on scientific management, which bids fair to cause a far more important revolution in all our industrial systems. Mr. Taylor's system of management can not be adopted without many modifications by an educational institution, but his system of experimentation can be. It is simply the careful collection of all the facts by an expert, their study by mathematical methods, the making of experiments to get more facts, their further study, and careful reasoning to arrive at correct conclusions. It takes years of time, thousands of dollars of money, and can only be undertaken with any probability of reaching valuable results by a scientific expert who is entirely unhampered by old traditions. The motto of the conservative is "whatever is is right," that of the scientific expert is, "whatever is is apt to be wrong; I am going to test it and find out whether it is right or wrong."

Here is the outline of an educational experiment to take ten years of time and cost half a million of dollars—less money, by the way, than one second-class university has spent on its equipment for athletics within a few years, and less than has been paid by some millionaires for a couple of paintings.

Appoint a commission of five well-educated men who are not connected with any educational institution, say a minister, a doctor, a farmer, a merchant and an engineer, to secure a wide diversity in points of view. Pay them $5,000 a year each for the first year, and a smaller sum in succeeding years, when their time will not be fully occupied, and provide them with an office, stenographer and clerk, and funds for traveling expenses. Let them spend a preliminary year in investigating actual educational conditions in this country, collecting facts, statistics and expert opinions, on which they should prepare a report. They should also report their opinion on what should be the course of education of a boy between the ages of 14 and 16, if he intends to go to work in the mechanical trades or in commerce at the age of 16, also what should be the course from 14 to 18 (1) if he intends to go to work at 18, (2) if he intends to enter a general college, (3) if he intends to enter a technical school. The second year the experiment is to be begun. Select a hundred boys who are ready to enter high school, of the majority of whom there is a reasonable probability that they will, if they prove fitted for it at 18, take a college course. Rent a preparatory school, or a portion of one, and have the boys taught, by selected teachers, in the courses laid down by the commission. Provide enough tutors or preceptors to insure that the education of the boys is properly supervised and that their time is not wasted. Continue their high school education, for as many of them as stay in school, for four years. During all this time the commissioners are to be studying methods of high-school teaching, and methods of measuring the efficiency of teaching, preparing practical standards of examination, not merely to test the memory of the scholars, as in ordinary examinations, but to test their mental and bodily powers. Find out not only what the boys know, as a mere act of memory, but what and how they think, and what they can actually do. Test not only the hundred boys, or as many of them as remain, but also boys in other high schools, by the same standards or by other standards that may be proposed by the high school teachers. Cultivate the same spirit of emulation for success in scholarship that now exists for success in the athletic field, but give them also enough athletics and other recreation to develop their bodies as well as their minds. Train them also in hygiene, in morals and in manners, to make them not only scholars but gentlemen.

During these four years the commissioners are also studying college administration, courses, methods of teaching and efficiency, and determining standards of measurement of efficiency. When the boys are through their preparatory course of four years, send them to such colleges as have been selected for them, have them take the courses for which they are fitted, provide tutors for them and watch their progress through the college, testing them by predetermined standards in comparison with other college students. At the end of the four year college courses, the commission is to report on the whole eight years' experiment. It will be found that many mistakes have been made, but probably not so many as would be made in an ordinary eight years' course of high school and college. The success of the experiment is not to be judged by the success of these selected boys, but by the value of the information obtained and reported on by the commissioners as to the various methods of teaching and of college administration and by the acquirement of standards by which academic efficiency may be measured in the future.

During the whole of the eight years' experiment the boys should be required to keep a diary in which they record what seems to be the most important items concerning their education, and they should once a year present to the commissioners a written report of their progress, keeping a copy for their own future use. Four years after they have graduated from college, when their minds are sufficiently mature, they should be asked to write critical reports of their educational career as it then appears to them. A study of these reports by the commission, which should be continued in existence for that purpose, would no doubt furnish fruitful ideas for further educational progress.

Cecil Rhodes did a noble work in establishing the foundation of the Rhodes Scholarships in Oxford. Andrew Carnegie has done a grand work in establishing the Carnegie Institutes for Scientific Research and for the Advancement of Teaching. Equally grand will be the work of him who shall establish a foundation for the application of the methods of scientific management to the improvement of academic efficiency.

This proposed plan is merely a suggestion. There may be a better plan, but whatever it may be it will take years of hard work and a large sum of money to accomplish the desired results. It might be undertaken by the Carnegie Foundation for the Advancement of Teaching, by the Russell Sage Foundation, or by the government, but the funds of these foundations are probably already fully employed, and judging by the past non-activity of the government in educational matters it might take twenty years of agitation before congress could be induced to make the necessary appropriation. The government has a Department of Agriculture which is making experiments for the farmer, to enable him to grow larger and better crops, a Bureau of Forestry which is trying to conserve our forests, a Bureau of Mines which is experimenting on improving the methods of mining and on the prevention of accidents. It has also a Bureau of Education, which publishes statistics of schools and colleges and some interesting papers on educational subjects, but which has never investigated academic efficiency or carried on an educational experiment. All educational reforms in this country have been originated by individual philanthropists or by individual universities. They do not come about by normal process of evolution in the educational world or by governmental action, with perhaps the single exception, the Morrill Land Grant Act of 1862, just fifty years ago. We therefore must look for a millionaire philanthropist to begin the great educational experiment which will lead to improving the methods of training our future citizens.

Our modern educational literature, addresses of college presidents, school superintendents, proceedings of societies, etc., all show the prevailing consensus of opinion that there is something seriously wrong with our whole educational system, and that instead of getting better it is constantly tending to grow worse. There exists also a great amount of ultra-conservatism and of mental inertia relating to the subject. It is high time that something practical be done in the way of reform.

William Kent

THE PROBLEM OF ORGANIZATION

II

THE PROGRAM

I have heard the title "philosophical biologist" applied to biologists who talk about such matters as this problem of organization. The honor is totally unmerited. The problem is in strictest sense a biological problem. No doubt philosophy is interested in its solution. Philosophy is and ever has been a field for speculation about unsolved biological problems. When biology and other natural sciences shall have solved all their problems, a considerable burden will have been lifted from the shoulders of philosophy. This helpful relation should, however, be a mutual one. Science will never solve its problems—at most, it will never do more than think it has solved them—unless it constantly realizes its own limitations and unless it frequently assures itself of the security of its foundations. Now, perhaps more than at any other time, the natural scientist stands in need of help which may well come from the philosopher. Is it not timely to raise the question as to the validity of the assumptions upon which science rests and the integrity of the methods by which we attempt to progress? Science is a tool by means of which the human mind seeks truth. This tool was not fashioned by some omniscient being and bestowed upon man for his use. He made it himself. Is it possible that the tool is now antiquated in its structure or so distorted and worn with long use that it no longer cuts true?

This problem of organization, in the sense in which I have stated it, is not only a biological problem. It is in a broad sense a physical problem. The materials of biological science consist of those substances which we call living, and the energies whose existence is revealed to us by the motions of the bodies composed of those substances. In the formation of a crystal we conceive of certain energies working in certain ways. Every formative event in an organism is a phenomenon of matter in motion. The investigation of form and organization reduces ultimately to an investigation of the energies involved in the motions and configurations of certain substances—biophysics. We would know the nature and mode of operation of these energies. Are they resultants or complexes of forms of energy with which we feel ourselves somewhat more familiar as we view them in the non-living? Or shall we find that living substance serves as the vehicle for energies peculiar to itself? In the latter case we shall simply have lengthened the known list of truly physical agents, that is, agents which are involved in the motions of molecules capable of analysis into known chemical elements. If any peculiar energetic properties of living substance should be demonstrated, whether such energies should be regarded as physical or non-physical is a question, not of fact, but merely of terminology.

But before we can preface our inquiry with "what" and "how," we must first ask, where? Our problem of organization is to a large extent the problem of determining the situation of the energies involved in the formation and harmonious operation of organic systems. One important step has already been gained. It is not so long since we looked hopefully to the environment in which the animal lives as the seat of some, if not all, of the energies of organization. Now we know that the germ possesses something more than merely the fundamental capacities for metabolism and growth. It is not a bit of indifferent plastic substance which is molded into shape by an elaborate complex of environmental forces. The energies which underlie organization are seated in the living substance itself. We now press our question one step further. Where, in relation to each system of the organism, are the energies which produce the organization of that system? Does each organic unit contain within itself an energy-complex sufficient for the part played by that unit in the system to which it belongs and in all higher systems, or shall we find more comprehensive energy-complexes transcending and dominating the intrinsic energies of all the units of a system?

It is in the developing organism that this problem of organization most insistently demands our attention. There we see the complex arising from what appears to be simple, system growing out of system, one organization after another derived from something which gave within itself no evidence of the existence of such organizations. The adult organism presents more nearly a static condition. When we understand how organic systems arise in ontogeny, we shall doubtless be in a fair way to know, if we do not then already know, how organization is maintained in the adult. Not only is the problem essentially a problem of the developing organism, but development offers to the investigator the most promising field of attack. He is by no means restricted to embryonic development. Regenerative development involves essentially the same processes as embryonic development. Precisely the same problems exist in both and for obvious practical reasons there are great advantages in favor of experimentally controlled regeneration as a means of discovering the location of the energies which produce organization.

Units of organization representing at least the more conspicuous grades of units which we see in the adult appear early in the ontogeny of metazoa. At first we see cells only, but very soon they become disposed in sheets or layers which, so far as visible structure is concerned, are the embryonic equivalent of tissues in the adult. These germ layers almost immediately undergo local modifications wherein we see the embryonic equivalent of organs. And before development progresses very far, structural peculiarities appear which correspond to specific characteristics of the whole individual. As the observer attempts to follow these events of ontogeny he soon finds himself confused and lost in so great a complication of developmental operations that he can no longer surely distinguish processes which are functions of the organization of cells as cells, and processes which are functions of the organization of embryonic tissues, and others which may be functions of units of organization of yet higher grade.

In our approach toward the problem of organization, a step of the utmost importance will have been gained when we have so far analyzed developmental operations that each component process may be positively identified as the function of a structural unit corresponding to an organization of a certain grade. We must at the outset clearly distinguish between processes which depend upon the operation of protoplasmic mechanism of one grade or another, and those events or conditions which are entirely independent of active physiological factors, as, for example, when the orientation of an egg cell in space and the distribution of some substance in the egg are directly due to gravity acting upon a heavy yolk. We must then determine, for each truly physiological developmental event, its value or position in the scale of organizations. We shall then have come to recognize in a certain developmental event, for example, a process which requires the operation of no organization higher than that which is fundamentally inherent in all cells. Any cells whatever, being in that particular physiological state—that is, as regards general metabolic conditions and the like—and placed in that particular physical environment, would exactly reproduce the developmental event which is before us. (I distinguish between the physical environment which includes all those conditions, such as temperature, pressure, chemical constitution of the medium, which are either independent of the structure of protoplasm, or only indirectly or remotely determined by it; and the physiological environment, essentially physical in nature, which includes the action of immediately present specific protoplasmic mechanisms.) Thus, it is conceivable that the earlier cleavage events, in at least some animals, are of this elementary character, inasmuch as they may show no definite or necessary relations to the organizations which appear later. In many cases the cleavage plan may be profoundly modified without important effect upon the subsequent development. In another instance we may distinguish a process for which the mechanism common to all cells is not adequate. It is, we will suppose, a process requiring, superimposed upon the essential cell mechanism, something else which results in the association together of numerous similar cells to constitute a layer or tissue of specific structural and physiological character; for example, the ectoderm. Beyond that in this case we need not go, for it becomes clear to us that any group of cells whatever, belonging to a tissue of this type and placed in a physical situation like that which exists in our supposed case, would exhibit that particular formative behavior which we have there observed. It is the essential point in this case that the process is one which has no necessary relation to the specific features of an organ or any higher complex of the individual. It may, indeed, be a process which participates in an important way in the development of an organ, but it contributes nothing of specific character to that organ inasmuch as tissue of the same type would play precisely the same rôle in the development of any other organ. It is therefore essentially a tissue process, being one which in no way bears the impress of any higher organization of the individual. The inherent propensity of an epithelium for investing a surface illustrates the tissue process.

In yet another instance we see a group of tissue elements undergoing changes which result in the establishment of some specific feature of an organ, such as the alveolus of a gland, or a Bowman's capsule of the kidney. Not every group of elements belonging to the type of tissue concerned would, even if placed in the physical situation occupied by the group under consideration, give rise to that same structure. It is clear, however, that a certain structure may upon occasion be formed by a group of elements other than that which would normally give rise to it. The tissue elements which normally do form a certain structure of high order, and those which in emergency can do so, must either contain within themselves or encounter in their environment an energy-complex which determines their activity. Something, therefore, must be added to or impressed upon the organization of an epithelial tissue or else something corresponding to the organization of the higher system must dominate the tissue organization. In this case, then, we have an example of a developmental event which owes its occurrence to energetic factors belonging to that grade of organization corresponding to those larger structural complexes which, in the ordinary anatomical sense, we call organs.

Finally we observe that organs develop in such a way that certain larger structural complexes are established. The several organs come to have, in a great variety of ways, very definite relations one to another. Especially conspicuous are the spatial relations which result in a certain body plan and general form. These larger relations and peculiarities characterize an organic unit higher in grade than the organ, namely, the organism as a whole or the individual or, as Haeckel names it, the person. We meet here precisely the same problem which we have met at every other level of organization. It is conceivable that absolutely indifferent cells exist—cells possessing no organization beyond that represented in the structural substratum common to all cells. When a cell becomes a tissue cell the fundamental cell organization must have been modified or something must have been added to it or something must dominate it. Further, a tissue as such, while possessing certain definite habits of growth, is indeterminate in form. In an epithelium one dimension, thickness, is approximately determined. In muscle tissue no dimension is determined. When a tissue becomes shaped into an organ or some part of an organ, the fundamental tissue organization must have been modified or something must have been added to it or something must dominate it. Still further there is no universal necessity governing the larger relations which exist amongst organs. We need only compare individuals of different species to see that similar and corresponding organs may be related to one another in a variety of ways so that individuals very unlike in body plan and general form result. Somewhere in ontogeny must exist energetic factors responsible for these larger features which characterize the individual as a whole. These factors may consist in modifications of organizations of lower orders or in something added to them, or they may consist in some energy-complex which transcends and dominates inferior organizations. Beyond denial *there is a specific something,* if it be nothing more than accidental chemical peculiarities of cells or smaller units, which corresponds to the organization of the individual as a whole. When, therefore, we see two organs arising in an embryonic cell layer which is otherwise lacking in visible differentiation, the distance between these two organs bearing to other dimensions in the embryo a ratio which is fairly constant for embryos of that species, we have before us an instance of the operation of the organization as a whole.

Many developmental events we may even now attribute, with a fair degree of confidence, to organizations of certain grade. Perhaps this is to a greater extent true of the later and more complex developmental operations than of the earlier and simpler. When we see a limited region of a tissue whose physical (in distinction to physiological) environment can not be far from homogeneous give rise to a structure of considerable complexity, it is highly probable that the action of an organization higher than that of the tissue is involved. But who can say whether the typical process of gastrulation is a function of cells or of cell layers? Do the factors concerned in gastrulation consist of a certain physical environment plus cell organization, or does this process depend essentially upon that higher organization in virtue of which the embryonic cells are associated together in a blastoderm, or does it involve specific factors higher in grade than those which determine organization as a mere cell layer? Or, indeed, does it involve no protoplasmic mechanism of any grade, being entirely dependent upon the physical environment and the gross physical properties of the blastula wall? While I am strongly of the opinion that gastrulation depends upon physiological factors of an order higher than cell organization, I can not offer absolute proof of it.

When we have identified the grade of the organization responsible for a particular developmental event, our next task—doubtless a much more difficult one—will be to discover the location of the dynamic factors which determine that event. Are they numerous, mutually independent, collectively uncontrolled, seated in the several elements of the responsible system, the event in question being merely the resultant effect of their separate operation? Or does some larger dynamic agent dominate the behavior of all the subordinate members of the system? When we have accomplished all this we may well feel encouraged to press on to the discovery of the mode of operation and the nature of these organic energies.

THE REALITY OF ORGANIZATION

Now the question arises whether this conception of organizations of various grades consists in anything more than an artificial and arbitrary classification of the complex phenomena of ontogeny and of the complexities of adult structure. Is it not of the same nature and value as our classification of animals? We have devised a scheme whereby we regard animals as segregated into a series of groups—species, genera and so on—subordinated one to another. We arbitrarily separate these groups by sharp lines. While the scheme expresses, to some extent, our ideas concerning the past history of animals, the groups themselves have no real existence "in nature," as we say. There these sharp lines do not exist. The species or other group has no definite limits in space, no form, no integrity. It has no organization as a whole. It is true that some close analogies may be drawn between phylogenetic history and ontogenetic history. We conceive of phylogeny as working from the simple to the complex. An original ancestor gives rise to series of animals which inherit peculiarities of the common ancestor and acquire various additional peculiarities. It is a process of differentiation. The oosperm is the original ancestor of all the cells of the individual. Ontogeny works from the simple to the complex. As it progresses cells "inherit" certain peculiarities from the common ancestor, the oosperm, and "acquire" other peculiarities which, so far as visible structural features are concerned, are new for that individual. Thus arises differentiation into the numerous types of tissue cells. (It is a curious inconsistency of the scientific mind that in ontogeny, where we can directly observe the history of the whole "race" of cells, having before us both the beginning and the end of their evolution, we are strongly inclined to believe that the "new" characters which appear as differentiation progresses were somehow potentially present in the common ancestor, the oosperm. Turning from this evolution of a cell kingdom to that larger evolution of an animal kingdom whose beginning and end we can not compass, of whose history only a brief and far from lucid chapter lies within our observation, we are equally strongly inclined to look for the causes of new characters anywhere under heaven rather than to attempt to think of them as having been somehow latent in a remote ancestor!)

In spite of striking analogies, phylogeny and ontogeny are quite clearly different in their mode of operation. The noteworthy feature of ontogeny is the concerted and coordinated behavior of many elements, either of the same kind or of different kinds. This harmonious action of elements gives rise to configurations which are definite and limited. Within phylogenetic groups such coordinated behavior of numerous individuals does not, in general, exist. We see something similar to it in the social organizations of some animals, but outside of the human species it is exceptional. Within the human species social organization is all-important. There are conspicuous analogies between the coordinated behavior of human individuals and the concerted action of the structural elements of an individual. We may well raise the question whether an unprejudiced and open-minded study of these analogies may not serve to guide us toward the truth in our attempt to interpret and "explain" the organization which we see within the individual. For the single cell and the whole multicellular animal are both living beings of one kind or another. This brings us to the edge of a vast subject whose full discussion at this point would be both premature and aside from our main thesis.

In general, then, phylogenetic groups lack organization. They possess no form unless it be geographical distribution, and this, even were our knowledge of it complete, must be so indefinite that it can be described only by means of arbitrarily drawn lines. In geographical distribution there is nothing closely comparable to the problem of form within the individual. Distribution has its problems, but the factors in it are relatively well known and intelligible. In general they consist, upon the one hand, of the various conditions contained within the physical environment and, upon the other hand, of the peculiarities in the organization of the individuals of the group. But these are the peculiarities of the organization of the individual *as an individual.* So far as form is concerned, and aside from the relatively rare phenomena of social organization, there is no evidence that a species or other group contains any organization higher than that of its members as individuals. *This lack of form in the phylogenetic group is most significant in the present connection, for it affords us an example of what results, in the way of form, from the action of physical environment on a group of living units possessing no organization higher than that of each individual as such.* In contrast to this we see everywhere in ontogeny precisely coordinated action of numerous elements resulting in forms which are not only definite, but elaborate. The physical environment in ontogeny may be considerably altered, yet these forms insist upon developing. Is it not futile, at this stage of our knowledge, to attempt to think of tissues originating in ontogeny by the action of a physical environment upon indifferent cells, or to think of organs arising similarly from indifferent tissues? While it is becoming that science, as well as scientists, should be modest in its claims, nevertheless to underestimate our knowledge merely retards progress. We now possess a large body of well-authenticated data upon ontogeny. I can not see in these data the least evidence that an environment which is, in the ordinary sense, purely physical—that is, devoid of specific physiological factors—has any power whatever to organize living substance. Upon the other hand there is every evidence that organization arises within the living substance and that the living organizes the non-living. To admit that originally the living arises spontaneously from the non-living by any such process as fortuitous concourse of atoms is explicitly to deny that the non-living has organizing power, for then organization begins by accident and higher organizations could arise only by continuance of accidents within the living substance itself, environment merely acting selectively. Even if chance is the creative element in phylogeny, it is not so in ontogeny. The development of the individual does not progress by trial and error.

We must admit, I believe, that in ontogeny cells are somehow directly and actively organized into tissues, and tissues and cells are still further organized into organs. The physical environment of a group of embryonic cells is no more capable of organizing those cells into a higher complex of elaborate form, than is that larger environment in which the whole animal lives capable of directly determining in ontogeny the form of the animal as a whole. I see no escape from the conclusion that specific organic or physiological factors—dynamic factors seated in protoplasmic structure—are involved in this organizing of lower structural elements into higher.

Furthermore, our analysis of the adult organism into organs, tissues and cells of various kinds is not, to any important extent, arbitrary. Here sharply drawn lines do exist. In the adult animal we do not find cells which constitute a continuous graded series between two distinctly different types of cells. A cell is either one thing or another. Neither do the several types of tissues in any individual merge indistinguishably one into another, as do species. In ontogeny a cell of one type may become transformed into a cell of another type, passing gradually through all the intermediate conditions. But the change is completed so that ultimately the cell is distinctly of one type and not of the other. If in the adult animal there are "indifferent cells," they are not indifferent in the sense of being indefinitely intermediate in character between cells of different types. Their very indifference constitutes them into a class sharply separated from differentiated tissue cells. Or they may be potential tissue cells which have not yet undergone their definitive transformation. When therefore we say that an animal is composed of organs, the organs of tissues, and the tissues of cells, we are not merely proposing a classification for the sake of injecting some order into complex structural data. Clearly, this scheme of organic structure represents substantial existence.

Our conviction of its reality is corroborated by the facts of development. It is true that ontogeny, like phylogeny, is a process within which at every point there is gradual transition from one form to another. Here again, then, are we not arbitrary in attempting to distinguish organizations of distinctly different grades? No, for there is this profound difference between phylogeny and ontogeny. In phylogeny the intermediate forms to a large extent persist as such, and each intermediate individual has precisely the same organic value as any individual of either of the species between which it is intermediate. In ontogeny the transitional stage is of relatively brief duration. While in this stage the element has the organic value of that unit of higher order which it is destined to become, and not that of any unit of lower order. It is intermediate therefore only in external aspect. It is potentially an element of a distinct type and it is assuming the structural characteristics of that type as rapidly as the organic energies concerned can elaborate them. Ontogeny, then, while it is in a sense a process in which there is gradual change from one thing to another, is nevertheless a process whose essential feature is the establishment of sharply marked differences. This comparison between phylogeny and ontogeny is, of course, open to the objection that we describe the developmental process with reference to its end, which we are able to observe, while the end of the phylogenetic process does not yet appear. Finally, the sequence in which structural systems make their appearance in ontogeny corresponds to the relations which they exhibit in the adult. In general we actually see, in the embryo, cells building up tissues, tissues building up subsidiary organs, and these uniting to form successively higher organic complexes. Were the sequence otherwise, we might well doubt if our conception of organizations of various grades, one subordinated to another, had any real value.

When, therefore, we attempt to liken a tissue to a species, the comparison soon becomes forced. It is quite clear that the tissue is a real thing, a definite configuration of matter, exhibiting certain physical and physiological properties which can only be regarded as the expression of a precisely corresponding dynamic complex. The species, no less real, is a human concept. In view, then, of the known facts of adult structure and of ontogeny, and by comparison of these facts with what we know of phylogeny, we can hardly escape the conclusion that our conception of the individual as representing, in its entirety, the highest of a descending series of organizations is, so far as it goes, a statement of biological truth.

CONSEQUENCES

Granting that this conception of the constitution of the individual organism represents substantial reality, the problems therein presented to us are not rivaled in importance by any with which biology has to deal. The problems of heredity and evolution are intimately, inseparably, related to this one of organization, for they, too, represent one aspect or another of the fundamental problem of organic form. When we understand the dynamics of form in the individual organism, we shall be well on our way toward understanding how a certain form is repeated in a series of genetically related individuals, and how in phylogenetic history form may undergo change. Of supreme importance to us is a knowledge of the nature of our own organization. It is perfectly clear to us that we ourselves are animals and that the attributes and powers which we possess are shared in greater or less measure by other living beings. So far as form and organization are concerned, we recognize other animals so nearly like ourselves that we include ourselves with them in the same sub-order of our scheme of classification. Whatever shall be found to be true regarding the nature of the organization of other organisms must inevitably be true of our own organization. The full realization of this truth must have for us a significance which it is now quite impossible to estimate. The intellectual value of so great an addition to our knowledge affords in itself sufficient motive and justification for the pursuit of that knowledge. Beyond this intellectual value lie utilitarian possibilities whose value exceeds conjecture.

If we shall succeed in proving to our complete satisfaction that organization is the resultant effect of the action of autonomous elements—that it is merely an appearance presented to us by the results of the curious accidents of molecules—our attitude toward ourselves and toward the universe in general must, so far as we realize the full import of that view, be profoundly affected thereby. If any one objects that this view, if true, is an undesirable truth and that we might better not know it, we can only reply with the faith that the truth can not hurt us, and in any case science is bent upon having the truth at all costs. Indeed, if this conception is carried to its logical conclusions, they who would prefer not to come into the knowledge of such truth can hardly help themselves, for whether they know it or not lies hidden amongst the secrets of molecular accidents yet to happen. In the mechanically deterministic universe to which this view of organization naturally, almost inevitably leads us—one in which our conscious life becomes a meaningless, even if interesting, replica of an inexorable physical concatenation—we may at least enjoy our freedom from responsibility for our own fate and the destiny of our race. Indeed, it may be permitted to us to hope that we are destined so to react within and upon the physical order that its psychic reflection shall come to contain less of pain and more of pleasure.

That other conception of organization which attributes the harmonious action of a system to forces which dominate the behavior of the members of the system appears, at the outset, more inviting to us and richer in possibilities for us. If we shall succeed in demonstrating to ourselves the existence of such dominating organic energies, we at once meet further questions of far-reaching importance. There would, however, still be enough left in the unknown respecting organisms to provide material for speculative inquiry which might tend, as we have already intimated, in the direction of any one of a variety of philosophical attitudes. In fact, in the present state of our knowledge this theory of dominating energies may be made, if one so pleases, as rigidly and narrowly mechanical and as severely deterministic as any other. Upon the other hand, it freely opens the way to the more flexible and more generous universe demanded by him whom I once heard William James designate as the "soft-minded man," in distinction to the "hard-minded" person of materialistic tendencies. The biologist, or biophysicist, however, and in certain important aspects of the problem the psychologist too, will press forward their investigations of form-dominating energies with, we will hope, supreme disregard for philosophical consequences.

With each ascending step in the series of organizations, the possible existence of a dominant factor becomes of greater significance. When we reach that highest level with which the biologist ordinarily has to deal, the organism as a whole, or the individual, we have to contemplate the existence of a dynamic agent which bears, to the form of the whole organism, somewhat the same relation that higher nervous centers bear to the coordinated muscular activities of the body as a whole. How far in the descending series of organizations is any such dynamic factor of the whole directly operative? Does it exert any direct influence upon lower units such as cells? What can be the nature of such energies? What is their relation to the energies with whose manifestations in the so-called inorganic realm we are inclined to feel ourselves somewhat more familiar? Do they endanger the integrity of that foundation rock of science, the principle of the conservation of energy? Finally, what is their relation to the conscious voluntary life of the individual?

When we trace the process of evolution in inverse order, everything organic appears to converge into a primitive and simple bit of living substance. Can we escape the conclusion that the elements of every power and attribute possessed by the highest and most complex organism are inherent in the simplest protoplasm? To this question no dogmatic answer, but at best merely a statement of opinion, can be given. In simple unicellular organisms and also in individual cells of multicellular organisms, the various operations involved in metabolism, in reproduction and in movement, are all carried on in one common protoplasmic body in which we can discover no separate mechanisms or organs corresponding to the several functions. (The temporary organs of mitosis appear to take their origin, upon occasion, from this common protoplasmic body.) Shall we not be obliged to credit the unicellular organism, at least—and if that, why not a leucocyte or a tissue cell too?—with the possession of some elemental germs of consciousness and will? Or is it more reasonable to assume that these attributes of the living have been created *de novo* and injected into organisms at a more or less advanced stage of evolution? If we admit the existence of some degree of consciousness and volitional action in a protoplasmic body in which there is not only no nervous structural mechanism, but in which all of the vital operations are carried on as functions of the whole and not as functions of localized separate mechanisms, we encounter the possibility that primitively all of the vital activities are equally linked with consciousness and will. If, now, there exists in this common protoplasmic mass a dynamic agent determining form, how shall we exclude it from this same relation with consciousness and will? Or, to suggest what is, to the general biological mind, the remotest of psychophysical possibilities, is this dynamic agent which organizes living substance identical with conscious will? To weave further this filmy tissue of possibilities, assume that primitively the determination of form, together with all other vital or protoplasmic operations, was somehow linked with primitive volition. How, then, in the course of evolution has the control of form, together with various other physiological operations, come to be so far removed, as in our experience they seem to be, from the voluntary life of the organism as a whole? Is it conceivable that in the full light of knowledge of the nature of organization we might acquire some degree of conscious and voluntary control, either direct or indirect, over these organizing and form-dominating energies? Herein, surely, would lie a most potent factor in the further evolution and destiny of our own race.

The contemplation of the imaginable consequences of this idea of dominant organizing energies overwhelms us beneath an avalanche of questions, of whose asking the only justification lies in the fact that they are properly biological questions for which biology at present has no answer. Certain of these questions may seem to carry us beyond the world of possibilities and into the misty realm of dreams. Yet, does not what we dream become possible even in the dreaming?

Herbert W. Rand
Harvard University

THE BEQUESTS OF THE LATE MORRIS LOEB

By the will of the late Morris Loeb, formerly professor of chemistry at New York University, large bequests are made to educational, scientific and charitable institutions. Subject to the life interest of Mrs. Loeb, $500,000 is bequeathed to Harvard University for the advancement of physics and chemistry. Twenty-five thousand dollars are bequeathed to the American Chemical Society for the establishment of a type museum of chemicals, to be established in the Chemists' Club of New York City, the U. S. National Museum or the American Museum of Natural History, and $2,500 is bequeathed to the National Academy of Sciences. His stock in the company owning the Chemists' Club is bequeathed to the company. Fifty thousand dollars are bequeathed to the Hebrew Technical Institute and $250,000 to the Solomon Betty Memorial Home for Convalescence. The residuary estate, subject to Mrs. Loeb's life interest, is to be equally divided among the Smithsonian Institution at Washington and the following New York institutions: The American Museum of Natural History, the Metropolitan Museum of Art, Cooper Union, the Hebrew Technical Institute, the New York Foundation, the Jewish Protectory and Aid Society, the Hebrew Charities Building and the Educational Alliance. The Smithsonian Institution receives its bequest to further the exact sciences. The American Museum of Natural History is to get a collection for the illustration of the industrial use of natural products in ancient and modern times. The Metropolitan Museum of Art is to purchase and exhibit objects illustrating the development of artistic handicraft in Europe and America. Cooper Union is to endow a professorship. The Hebrew Technical Institute is to establish technical courses for mechanics. The Jewish Protectory and Aid Society bequest is for the relief of employees. The Hebrew Charities Building is to use the money to establish a library and to reduce the rent for the charitable societies occupying the building. The Educational Alliance is to devote the gift to work among women and children.

SCIENTIFIC NOTES AND NEWS

Dr. Carl L. Alsberg, chemical biologist of the Bureau of Plant Industry, has been appointed chief of the Bureau of Chemistry in succession to Dr. Harvey W. Wiley.

Mr. W. H. Fox, of Philadelphia, a student of art, has been appointed curator in chief of the Brooklyn Museum to fill the vacancy caused by the resignation of Dr. Frederic A. Lucas, to accept the directorship of the American Museum of Natural History.

The anniversary meeting and dinner of the Royal Society was held on November 30. Sir Archibald Geikie made the annual address. At the dinner toasts were proposed by Sir Rickman Goldee, president of the Royal College of Surgeons, by Prince Lichnowsky, the German ambassador, and by Professor Elie

Metchnikoff. Sir Archibald Geikie spoke as follows in regard to the award of the Buchanan medal: "This medal is awarded every five years in recognition of distinguished services to hygienic science or practise in the direction either of original research or of professional, administrative, or constructive work, without limit of nationality or sex. It has this year been adjudged to Colonel William Crawford Gorgas, for his remarkable services under the American government, in combating the terrible scourge of yellow fever. As chief sanitary officer at Havana, Cuba, he there for the first time applied those sanitary methods by which the yellow fever was almost entirely eradicated from the place. This marked success led to his being entrusted in 1904 with a similar but greater task in the Panama Canal zone, where the same disease was rampant, and where he is still engaged. His success in that region has been not less conspicuous."

The Nobel prizes were presented by the King of Sweden at a banquet in Stockholm on December 10, when those to whom awards had been made were present, including Dr. Alexis Carrel, of the Rockefeller Institute, New York City.

The American Society of Naturalists will hold its annual dinner at the Colonial Hotel, Cleveland, on the evening of January 2, when the presidential address will be given by Professor E. G. Conklin, of Princeton University, on "Heredity and responsibility." Members of other scientific societies are invited to be present and may obtain tickets at a cost of two dollars from the secretary of the society.

Dr. Franz Pfaff has resigned from the chair of pharmacology and therapeutics in the Harvard Medical School. He plans a visit to California and Honolulu.

Mr. T. Francis Connolly, of the Solar Physics Observatory, South Kensington, has been appointed an assistant-inspector of scientific supplies at the India Stores Department, Lambeth.

On November 29 Mr. Edgar A. Smith, assistant-keeper in the zoological department of the Natural History Museum, was, in view of his approaching retirement, presented by the director, Dr. L. Fletcher, F.R.S., on behalf of the subscribers, including many of his colleagues and other friends, with silver plate and other objects.

The special board for biology and geology of Cambridge University has adjudged the Walsingham Medal for 1912 to Mr. Edgar Douglas Adrian, B.A., Trinity, for his essay entitled, "On the transmission of subnormal disturbances in normal and in incompletely recovered nerve."

Professor Francis E. Lloyd, of McGill University, has been elected a corresponding member of the Centro de Sciencias, Letras, e Artes, Campinas, S. Paulo, Brazil, especially in recognition of his work on the desert rubber plant, guayule.

Mr. J. T. Saunders, last year demonstrator in invertebrate embryology in the University of Toronto, has been elected to a fellowship at Christ's College, Cambridge.

Mr. N. Cunliffe, B.A., Trinity, has been appointed to the research studentship in medical entomology at Cambridge University.

Dr. Theodore Lyman, of Harvard University, and Mr. N. K. Hollister, of the division of mammals of the U. S. National Museum, have returned from an expedition to the Altai Mountains, Siberia and Mongolia, with a large collection of mammals, which will be divided between the U. S. National Museum and the Museum of Comparative Zoology of Harvard University.

The "Elements of Physical Chemistry" (fourth edition) by Dr. Harry C. Jones, professor of physical chemistry at the Johns Hopkins University, has been translated into Russian and Italian.

Dr. Harvey W. Wiley lectured at the University of Illinois on December 7, and was entertained at dinner by Phi Lambda Upsilon, the honorary chemical fraternity.

Professor Walter S. Tower, of the University of Chicago, has lectured before the Geographical Society of Chicago, on "A Journey through Argentina."

Joseph H. James, professor of chemical engineering in the Carnegie Institute of Technology, Pittsburgh, delivered the address at the annual meeting of the Columbus Section of the American Chemical Society on the subject, "Acetylene Gas, its manufacture, transportation and storage."

Professor William T. Sedgwick, of the Massachusetts Institute of Technology, lectured on December 11 in the Barnum Museum, Tufts College, on "Sanitary Biology."

Dr. John M. Macfarlane, professor of botany in the University of Pennsylvania, delivered a lecture on December 9, before the Natural History Society of Wilmington, Del., on "Evident and Hidden Flowers and Plants."

Professor Lightner Witmer, of the psychological department of the University of Pennsylvania, addressed the Brooklyn Training School for Teachers on December 2, on the treatment of gifted children in the schools and the Montessori system.

On November 25 Professor Hugo de Vries, of Amsterdam, lectured at Rutgers College on "A New Conception of the Evolution Theory." On the same day Dr. Charles P. Berkey spoke before the New Jersey State Microscopical Society on "Geology and Engineering in the Catskill Aqueduct."

The Royal Society of Edinburgh proposes to commemorate in 1914 the tercentenary of the announcement of the discovery of logarithms by John Napier.

Sir George Howard Darwin, Plumian professor of astronomy and experimental philosophy at Cambridge University, distinguished for his contributions to our knowledge of the tides and kindred phenomena, has died at the age of sixty-seven years.

The death is announced, in his seventy-ninth year, of Sir Charles Whitehead, a British authority on agriculture.

Professor Wilhelm Fiedler died in Zürich on November 19 at the age of eighty-one years. Professor Fiedler is known by his investigations in descriptive geometry in connection with the geometry of position. He also published German translations of a number of Salmon's works on higher geometry.

Mr. L. S. Camicia, of Valdez, Alaska, a jeweler and optician, died in May, 1912. He was a Swiss, largely self-educated and intensely interested in nature. From 1898 to 1912 he visited the Valdez glacier once a year in the same month and accurately measured its retreat. He is the only resident of Alaska who is known to have maintained annual observations of the behavior of a glacier. He also kept a continuous daily weather record for the fourteen years at his residence in Alaska, and a series of manuscript notes on times and durations of earthquakes at Valdez that checks well with the accurate seismograph records.

The legislative council of Mauritius has voted £200 as a contribution towards the fund which is being raised for the London School of Tropical Medicine. The fund has now reached £50,000.

The alumni of the University of Minnesota living in Washington have been planning for the past two years to present the university with ground for a marine biological laboratory and station in the state of Washington and have now made a formal offer to the regents of ten acres on Cypress Island, one of the San Juan group, about fifty-five miles directly north of Seattle. The island is about four and a half miles long and nearly two miles wide. There is a freshwater lake and a fine spring. This particular tract of ground was chosen, after a very thorough survey of the country, in order to secure the very best possible location for such a station. The alumni propose to present this ten-acre tract to the university, and to erect a building or buildings suitable for the use of the station. They also offer to provide any minor additions that the university may require and will support two or three, or possibly more, scholarships.

In the *Proceedings of the American Academy of Arts and Sciences,* Volume 48, Number 11, pp. 389–507, November, 1912, Professors Edwin B. Wilson and Gilbert N. Lewis have published a long and systematic account of the theory of relativity under the title, "The

Space-time Manifold of Relativity. The Non-Euclidean Geometry of Mechanics and Electromagnetics." The paper contains an elementary account of the non-Euclidean geometry which lies at the basis of any real treatment of relativity free from imaginaries. The vector analysis germane to this geometry is developed from the start, and is not only interesting for its applications to the subject at hand, but instructive as an example of non-Euclidean vector analysis. A place of fundamental importance is given to the singular or minimal elements of the space, that is, to lines of zero length, planes of zero area, and so on. By this means radiant energy and momentum may be treated with great simplicity and power. In particular the questions of the continuous and discontinuous in physics may be discussed from an illuminating point of view. The methods adopted make it possible to develop the formulas connected with the electron, whether considered as a point charge or as continuously distributed, without any approximations, in particular without the common concept of "quasi-stationary" motion. Like all the papers appearing in the *Proceedings* of the Academy this memoir is published separately in paper covers and may be purchased separately directly from the American Academy, 28 Newbury Street, Boston.

The high commissioner for Australia has, as we learn from *Nature,* received official information of the arrangements that are being made for the visit of the British Association to Australia in 1914. A federal council has been formed, under the patronage of the governor-general, with the prime minister as chairman. The members of the association will arrive at Fremantle on August 4, Adelaide August 8, Melbourne August 13, Sydney August 20 and Brisbane August 27, and those returning home by the shortest route will reach London on October 11. The Commonwealth has granted £15,000 to be handed to the British Association to cover the passages of not fewer than 150 official representatives, including selected Dominion and foreign men of science. Dr. Rivett has been appointed organizing secretary, and will visit London next year. The governments of the several states offer special facilities for prolonged visits of men of science interested in special problems in Australia.

Anthracite coal was at one time an important factor in blast-furnace practise, but its use in that line of industry has now almost entirely ceased, according to E. W. Parker, of the United States Geological Survey, as it has been supplanted by coke made from bituminous coal. The principal demand for anthracite will be in the future, as it has been in the more recent past, restricted largely to domestic trade, for which such sizes as furnace, egg, stove and chestnut are required. The breaking down of the lump coal, which was formerly a marketable product, for the preparation of the domestic sizes results in a much larger proportion of the small or undesirable sizes, all of which are sold at less than the cost of production. All the profits on the mining operations must be obtained from the prepared domestic sizes, for the revenue obtained from the smaller sizes, which are sold largely in competition with bituminous coal for steaming purposes, serves only to reduce the cost of the domestic sizes. The conditions under which the anthracite mines are operated, the greater depths to which the workings are carried, the consequent increased expense of mining and the increasing cost of labor all contribute to make anthracite fuel more and more a luxury. During recent years the anthracite operators have adopted the policy of making an allowance of 50 cents per ton from circular prices for domestic coal purchased in April of each year, with an advance of ten cents per ton for each succeeding month until the schedule prices are restored in September. This has had a more salutary effect in steadying the anthracite trade than any other action taken by those controlling the anthracite industry. Its purpose is to encourage the purchase of coal in the spring and early summer, making the cellars of the consumers the storage places for the following winter, and at the same time to cause the mines to be operated more regularly, thus giving steadier employment to employees throughout the year.

UNIVERSITY AND EDUCATIONAL NEWS

Mrs. A. D. Juilliard, of New York, has given $100,000 to Colorado College for a new gymnasium as a memorial to her father, the late Frederick H. Cossitt.

Fifty thousand dollars have been bequeathed to the University of Pennsylvania, for two additional dormitory houses, by the late Dr. Richard A. Cleeman, as a memorial to his brother, Ludovic C. Cleeman.

The Rhode Island State Board of Education has awarded at Brown University scholarships, under the new law providing for an annual appropriation of $5,000. The recipients of these scholarships number twenty-two, and each is required to make declaration of an intention to follow teaching as a vocation and to give a promise of serving the state as a teacher, principal or superintendent for at least two years.

St. John's College has offered £500 as a contribution to the equipment of the Solar Physics Observatory on its installation in Cambridge.

Professor Lewis Perry, who holds the chair of English at Williams College, has been offered the presidency of Wells College, Aurora, N. Y.

Mr. W. B. Hardy, M.A., Gonville and Caius, has been appointed university lecturer in physiology at Cambridge University.

DISCUSSION AND CORRESPONDENCE

ON ORTMANN'S "NOTES UPON THE FAMILIES AND GENERA OF THE NAJADES"

For the malacologist struggling along with the current unnatural and erratic classification of the "river-mussels," Ortmann's "Notes upon the Families and Genera of the Najades"[1] clears up many difficulties. While it has long been admitted that the only key to the natural genera lay in the differentiation of the soft parts, it has remained for this author within the last two years[2] to break the trammels of convention and indicate the fundamental points of Naiad classification.

[1] *Ann. Carnegie Mus.*, XIII., No. 2, July, 1912.

[2] "A New System of the Unionidæ," *Nautilus*, XXIII., 1910, pp. 39–42.

At the outset Ortmann calls attention to the difficulty of correlating the characters of the shell with the relationships as indicated by the anatomy and mentions the occurrence of analogous types in unrelated species. In the current number of the *Proceedings of the Malacological Society of London* the writer has discussed this problem with the view of showing that in the more primitive forms the shells were ponderous, subquadrate and possessed a well-developed hinge, while in the more specialized forms the shells are comparatively thin, posteriorly elongate, the hinge tending to become edentate. It has happened in several instances, however, that the degeneration of the hinge has not proceeded *pari passu* with the specialization of the anatomy, but has been accelerated or retarded.

The peculiar structure of the gill of the Margaritanidæ is discussed in some detail. In the writer's opinion the oblique arrangement of the synapticulæ connecting the two lamellæ is not to be correlated with the water tubes of the more specialized Naiad gill, but is merely an incidental feature. Ortmann states that the gills are without septa, but his drawings show them in rudimentary form. They are, however, only united at infrequent intervals, due to a tendency for one or more of the faint but regular bead-like papillæ scattered along their length to develop sufficiently to fuse with its neighbor on the opposite plate, forming one of the scattered interlamellar tissues described. A more extensive fusion of the papillæ would result in the structure occurring in *Hyria*.

The family Unionidæ, as admitted, might with considerable propriety be broken up into several natural groups. The Lampsilinæ are not at all closely allied to the other genera and seem fully entitled to family rank. The group represented by *Quadrula* and that by *Pleurobema* and *Elliptio* are allied and should be placed in the Quadrulidæ (Quadrulinæ Von Ihring) though the two latter genera might be regarded as forming a distinct subfamily owing to the restriction of the brood-pouch to the outer gills. The European Unioninæ are more closely related to the Anodontinæ and to these two groups the term Unionidæ ought to be confined. The Asiatic *Parresia* and *Lamellidens* are not known to the writer but it would seem that they were derived from a different Margaritanoid stock and may form a family by themselves. Omitting these the general grouping adopted by the writer is as follows:

Superfamily Unionoideæ.
- Family Margaritanidæ Ortmann, 1910.
- Family Hyriidæ Swainson, 1840 (emend.).
  - Subfamily Hyriinæ s. s.
  - ? Subfamily Mutelinæ Gray, 1847.
- Family Quadrulidæ Von Ihring, 1901.
  - Subfamily Quadrulinæ s. s.
  - Subfamily Pleurobeminæ Hannibal, 1912.
- Family Unionidæ Swainson, 1840.
  - Subfamily Unionidæ s. s.
  - Subfamily Anodontinæ Swainson, 1840.
- Family Lampsilidæ Von Ihring, 1901.
  - Subfamily Lampsilinæ s. s.
  - Subfamily Propterinæ Hannibal, 1912.

Symphynota and *Anodonta* in the sense used by Ortmann are probably composite genera due to an analogous degeneration of the hinge in several allied stocks. "*Anodonta*" *imbecillis* appears to group with *S. compressa* in *Symphynota* though perhaps entitled to subgeneric distinction. *S. complanata* is rather allied to "*Anodonta*" *cataracta* and its subspecies *grandis*. Neither of these are *Anodontas* in the true sense of the word, for that group like *Unio* and *Migranaja* belongs to the Old World and the west coast of North America. The *complanata-cataracta* group might take the name *Pterosygna* Raf. (type *Alasmodonta complanata* Barnes) if that name is available. *A. costata* probably belongs here also but seems a rather aberrant member.

The writer would be inclined to give *Caruncula* and *Micromya* generic rank as distinct from *Eurynia*.

Considering the fact that Dr. Ortmann has had to deal with a group in which the nomenclature of the genera has been very imperfectly worked out and the wealth of nominal species and varieties compared with those which may be ultimately recognized as valid is amazing, he is certainly to be congratulated for the care he has taken in presenting clearly a large mass of facts without falling into any serious nomenclatural pitfalls.

Harold Hannibal
Stanford University, Cal.,
August 3, 1912

SOME REMARKABLE DISCOVERIES REGARDING A COMMON HOUSEHOLD INSECT

The literature of the nature-study movement abounds in remarkable statements regarding the morphology, development and biology of bird, beast and fowl, but scientific men have hesitated to discard the older theories in favor of unsupported statements from such sources. The public can hardly be expected to be so suspicious of the publications of the United States Public Health Service and it would seem that some of the many astounding facts recently disclosed regarding the common bed-bug should receive wider currency than is assured by their publication in Public Health Reports, for November 15, 1912, pp. 1854–1856.

The early history of this pest is shrouded in mystery, but we are informed that it is not at all improbable that when our arboreal forebears forsook tree-top for caves they took this little six-legged pest with them.

This seems to be more likely because the English sparrows and the swallow harbor a very similar species, and not infrequently their nests are crowded with these vermin.

The biting apparatus of this parasite is quite elaborate, and consists of several parts. In biting, the bug anchors itself to the skin with a couple of hooks called mandibles, and then inserts the maxillæ, which are shaped like two gutters, the concave surfaces of which look towards each other.

Normally it feeds upon human blood, but lacking this it will live upon decaying wood or the dust in floor cracks.

The eggs are somewhat rounded, white objects, and are laid in collections in crevices or other suitable places. In about a week or ten days after they are laid the eggs hatch out as little worms, called larvæ; these are yellowish white in color at first but later become almost brown. They feed and go into a resting state, from which they emerge as pupæ; they then shed their skins five times and at last become full grown adults.

To illustrate its activity in its search for food

may be quoted the story of the ingenious traveler who, in order to keep bed-bugs out of his bed, set the legs of the bedstead in pans of water, whereupon the bed-bugs climbed the walls, got out on the ceiling over the bed and dropped down upon the victim. In order to thwart his enemies the traveler was obliged to raise his umbrella.

As this is not marked as a joke, and is no more so than the other statements, we may expect to see it quoted as from good authority.

Much important information regarding the bed-bug has been published by the Bureau of Entomology, and one is surprised that so many interesting and valuable facts should have escaped the attention of Dr. Howard and Dr. Marlatt and their capable assistants. It is regrettable that the information contained in the article before us was not shared with them before it was printed in a government periodical, which the public is entitled to regard as authoritative.

Wm. A. Riley

SCIENTIFIC BOOKS

A Manual Flora of Egypt. By Dr. Reno Muschler, Assistant in the Royal Botanic Gardens, Dahlem-Berlin; Corresponding Member of the "Institut Egyptien," and others. With a preface by Professor Paul Ascherson and Professor Georg Schweinfurth. Berlin, R. Friedländer & Sohn. 1912. Octavo, in two volumes. Pp. 12 + 1312.

The author tells us that "the history of botanical discovery in Egypt falls conveniently into two periods." These chronologically are (1) from 1761 to 1867, and (2) from 1867 to the present. In the earlier period we have Forskal's "Flora Aegyptiaco-Arabica" (1775), Delile's "Flore d'Egypt" (1813), Baker-Webb's "Fragmenta Florulae Aethiopico-Aegyptiacae" (1854), and in the later period, Schweinfurth's "Beitraege zur Flora Aethiopiens" (1867), Ascherson and Schweinfurth's "Illustration de la Flore d'Egypt" (1887), Volkens's "Die Flora der Aegyptish-Arabischen Wüste auf Grundlage anatomisch-physiologischer Forschungen" (1887), Sickenberger's "Contributions a la Flore d'Egypt" (1908). To this list, of course, should be added Boissier's "Flora Orientalis" (1867–1888), covering a vastly larger field than Egypt.

The present work is the outgrowth of the labors of Ascherson and Schweinfurth, who "for some time already had decided upon the publication of a more adequate work dealing entirely with the Egyptian flora, but, owing to a great many more urgent tasks which took up all our time, we had to put off the realization of this plan from one year to another." Accordingly the labor of preparing the present work was entrusted to Dr. Muschler, who had at his disposal "the most extensive and best arranged collections ever made in Egypt."

In a chapter on Phytogeography and Geology in the appendix Egypt is divided into five regions, as follows: (I.) the Mediterranean Region, including the extreme northern area; (II.) the Nile-Delta Region, including the Delta proper at the north, and the Nile valley to Aswan near the Nubian frontier; (III.) the Oases of the Lybian Desert; (IV.) the Desert Region, including the Lybian, Isthmic, Northern and Southern Arabian deserts; (V.) the Red Sea Region. In the treatment of these regions many interesting botanical facts are brought out in connection with a discussion of their geological and physiographical features.

We may well quote several paragraphs in regard to the Desert Region:

The desert is characterized by a vegetation of fairly uniform character in its main features. The means whereby the existence of these desert plants is preserved reside rather in the peculiarities of their organization than in any specially favoring influences of the environment. The most prominent feature of this organization is the capacity which the vegetative organs have acquired to resist factors so inimical to life as heat and drought, factors whose common tendency is to annihilate all living things. Though the minute details of these multifarious protective arrangements are not visible to the naked eye, they find obvious expression in the external conformation of the various organs of the plants. Thin-stemmed plants of delicate appearance have tubers or tuberous roots (*Erodium hirtum* and *Erodium arborescens*) sunk deep in the strong ground for the storing of reserves of nutriment adequate to maintain them alive through long months of absolute drought. The same end is gained in other delicate herbs by the possession of an enlarged woody basal portion. Then again, the tendency to general lignification through all the parts of the plants affords a capacity for resistance to many members of the families *Cruciferae* and *Compositae*, families known to us at home by their herbaceous, unprotected representatives. To restrict evaporation due to wind and solar radiation the desert flora exhibits a high degree of reduction in the surface area of its members. This principle is illustrated in numerous instances by poverty of foliage and considerable spininess, whilst in apparent contradiction of this tendency one often finds the surface of the plant clad in a hairy covering or with glands and superficial excretions of wax or resin or strongly aromatic substances. . . . Further we find plants with smooth or shiny, thick and fleshy, leaves. Nature does not work on one plane, but provides for every case special means of protection and fresh weapons to carry on the struggle. Side by side with the thorn-bristling *Zilla spinosa* we find the thick-leaved, wax-coated *Capparis spinosa*, whilst near by are the hedgehog-like *Astragalus* and *Fagonia*, and the soft, fleshy, fiberless *Mesembrianthemum*. In marked contrast, too, are the *Chenopodiaceae*, a similar almost leafless everlasting-woody throughout, and one would think indestructible—and the delicate *Parietaria* with its thin and battist-like foliage. Among the life-destroying agencies of the desert, the omnipresent salt should be mentioned.

. . . .

Perennial plants are just about half as numerous as the delicate annuals. Their existence is independent of the fluctuating and variable annual winter rains. They shoot anew and blossom even after a rainless or all but rainless winter. In marked contrast are the annual herbs which depend absolutely upon the rainfall; nor is all rain of equal value in promoting their development. For a rich spring vegetation of annuals, the rain should fall about the end of February and the early part of March, at which time the growing heat of the sun is capable of promoting germination. Trees are hardly met with in the district.

As to the plants themselves, this flora presents some odd features. Thus we find only one true fern (*Adiantum capillus-veneris*), and the only gymnosperms are two species of *Ephedra*. The grasses (*Gramineae*), legumes (*Leguminosae*) and composites (*Compositae*) are the larger families, there being 152 species of the first, and 175 of the second, and 188 of the third. The larger genera in these families are *Panicum* (14 sp.), *Aristida* (14), *Eragrostis* (9), *Bromus* (10), *Trigonella* (12), *Medicago* (16), *Trifolium* (15), *Lotus* (14), *Astragalus* (28), *Anthemis* (10), *Centaurea* (16). Of *Carex* there are only 3 species, and there are no orchids. Of *Rosaceae* there are 5 species, in as many genera. There is but one species of *Ericaceae*. There is no species of *Solidago*, nor even of *Taraxacum*.

The tree-producing genera with which we are familiar are mostly wanting, as *Quercus*, *Fagus*, *Acer*, *Ulmus*, *Fraxinus*, which are not represented, while *Salix* has 3 species, and *Populus* 1. Yet Egypt is not lacking in tree species, as witness the following list of genera, each represented by one species unless otherwise indicated: *Phoenix*, *Cocos*, *Hyphaene*, *Morus*, *Ficus* (3), *Acacia* (6), *Melia*, *Pistacia*, *Mangifera*, *Zizyphus* (2), *Rhamnus*, *Sterculia*, *Tamarix* (6), *Carica*, *Elaeagnus*, *Eucalyptus*, *Olea*, *Plumiera*, *Nerium*. Many readers will be surprised to learn that *Ricinus communis* (the castor bean) is "an evergreen, usually large shrub."

The foregoing will give some idea as to the interesting matter to be found in this important addition to systematic and ecologic botany.

Charles E. Bessey
The University of Nebraska

Gas-Engine Principles. With Explanations of the Operation, Parts, Installation Handling, Care and Maintenance of the Small Stationary and Marine Engine, and Chapters on the Effect, Location, Remedy and Prevention of Engine Troubles. By Rodger B. Whitman. Published by D. Appleton and Company, New York and London. 1912.

As stated on the paper cover, "'Gas-Engine Principles' is a guide for the user of the small stationary internal-combustion engine.

The first chapters explain the principle of operation of the gas engine, and describe in detail the various constructions that are employed in the engines on the market. The remainder of the book is given up to practical explanations of the setting up of a new engine, the economical operation of engines, engine care and maintenance, and explanations of the troubles to which engines are subject, together with their remedy and prevention. The book is written with the greatest possible simplicity of expression. The illustrations are especially prepared line drawings made by the author, each one specifically illustrating some particular point of construction."

The book is well written and admirably covers the ground claimed for it, though at times at the expense of scientific accuracy. It should not only prove an excellent guide to the amateur and the operator of small stationary plants, but it will be found extremely useful to those more scientifically inclined, as it supplies numerous details of construction and methods of operation that can not be given space in a scientific work, such as the details of carbureters, ignition systems and spark plugs.

In attempting to explain electrical and thermodynamic phenomena, the author at times uses illustrations that would not stand the test of scientific accuracy and that would be misleading to those who had no further knowledge of the subject. In the first chapter he repeatedly speaks of converting water into a gas and gasoline into a vapor. If the term "vapor" could be understood by the reader in one case there should be no difficulty about it in the other. In comparing the relative efficiency of gas and steam engines, he states on page 6 that: "When a fire is built under a boiler only a small part of the heat is actually applied to heating the water, for most of it passes up the chimney or is otherwise wasted." The author evidently confuses the chimney wastes with the exhaust wastes. Boiler efficiencies of 70 per cent. are not uncommon.

On page 10, the statement, "The compression of the charge turns any liquid gasoline to vapor" might be open to question.

The most serious misconception that the reader might gain is that electricity is a substance like water or air and that there is an unlimited store of electricity in all substances which only has to be set in motion to do work. This is certainly contrary to the ordinary conception of electrical energy and could only be defended by resorting to the electron theory, which would be beyond the scope of the work. The author regards a dynamo as a machine for setting electricity in motion.

In describing the principle of action of the Bosch high-tension magneto, when the current in the primary coil is broken, the author states, on page 145, that "The sudden rush of intense primary current into the secondary winding raises sufficient pressure to enable the current to jump across the spark plug gap," ignoring the real cause for the induced current in the secondary. This action was probably inferred because the diagram shows the secondary winding to be in series with the primary, for in describing other types, where the windlings are separated, he correctly assumes the high-tension current in the secondary to be caused by the rapidly dying magnetism or change of magnetic flux in the iron core.

C. R. Jones

West Virginia University

SCIENTIFIC JOURNALS AND ARTICLES

The closing (October) number of volume 13 of the *Transactions of the American Mathematical Society* contains the following papers:

W. A. Hurwitz: "On the pseudo-resolvent to the kernel of an integral equation."

G. A. Miller: "Infinite systems of indivisible groups."

J. K. Lamond: "Improper multiple integrals over iterable fields."

T. H. Gronwall: "On a theorem of Fejér and an analogon to Gibbs's phenomenon."

W. H. Roever: "The southerly and easterly deviations of falling bodies for an unsymmetric gravitational field of force."

Dunham Jackson: "On approximation by trigonometric sums and polynomials."

Also notes and errata to volumes 7 and 13.

The opening (October) number of volume 19 of the *Bulletin of the American Mathematical Society* contains: "Surfaces of revolution of minimum resistance," by E. J. Miles; "Shorter Notices": Riquier's Les Systèmes d'Equations aux Dérivées partielles, by Edward Kasner; Study's Ebene analytische Kurven und zu ihnen gehörige Abbildungen, by Arnold Emch; Coffin's Vector Analysis, by J. B. Shaw; Berichte und Mitteilungen der Internationalen mathematischen Unterrichtskommission and Auerbach und Rothe's Taschenbuch für Mathematiker und Physiker, by E. W. Ponzer; Bonola-Carslaw's Non-Euclidean Geometry, by Arthur Ranum; Barbarin-Halsted's Géométrie rationelle, by R. C. Archibald; Smith and Granville's Elementary Analysis, by Jacob Westlund; Hawkes, Luby and Touton's Second Course in Algebra, by J. V. McKelvey; Jacob's Calcul mécanique, by C. C. Grove; Schwahn's Mathematische Theorie der astronomischen Finsternisse and Haret's Mécanique sociale, by Kurt Laves; "Notes," and "New Publications."

The November number of the *Bulletin* contains: Report of the nineteenth summer meeting of the society, by F. N. Cole; "A few theorems relating to Sylow subgroups," by G. A. Miller; "Theorems on functional equations," by A. R. Schweitzer; "Double curves of surfaces projected from space of four dimensions," by S. Lefschetz; Review of Southall's Geometrical Optics, by E. B. Wilson; "Shorter Notices": Rogers-Salmon's Analytic Geometry of Three Dimensions, by Virgil Snyder; Volume 3 of Picard's edition of the Works of Charles Hermite, by James Pierpont; Heiberg's Naturwissenschaften und Mathematik im klassischen Altertum and Mannoury's Methodologisches und Philosophisches zur Elementar-Mathematik, by D. E. Smith; Weber und Wellstein's Encyklopädie der Elementar-Mathematik, volume 3, part 1, and Korn's Freie und erzwungene Schwingungen, by J. B. Shaw; Richard's Assurance complémentaire de l'Assurance sur la Vie, by C. C. Grove; Vahlen's Konstructionen und Approximationen, by E. W. Ponzer; "Notes," and "New Publications."

The December number of the *Bulletin* contains: General report of the fifth international congress of mathematicians at Cambridge, by Virgil Snyder; Report of Section I of the Congress (arithmetic, algebra, analysis), by A. B. Frizell; "Shorter Notices": Boehm's Elliptische Funktionen, Part 2, by L. W. Dowling; Darboux's Eloges académiques et Discours, by G. A. Miller; Hedrick and Kellogg's Applications of the Calculus to Mechanics, by D. C. Gillespie; "Notes," and "New Publications."

CONDITION OF THE EARTH'S CRUST

The results of measurements of the force of gravity at various points on the earth, as well as the results of triangulation operations, were early recognized as indicating that the earth's crust is in a condition of approximate equilibrium, to which the name "isostasy" has since been given.

The development by Mr. Hayford of a new method of reduction of gravity observations, in which for the first time the effect of the topography of the whole earth has been taken into account, has furnished strong additional proof of the general fact that the condition of isostasy exists, that elevated regions, whether plains or mountains, are, so to speak, floated on the earth's surface by reason of the lesser density of the underlying materials, and that ocean bottoms are depressed because of the greater density of the materials beneath.

The question of how close is this adjustment, of how local is the compensation of surface irregularities, is of considerable interest. If the compensation is quite complete for each small topographic feature, so that a single mountain or hill or canyon is exactly compensated by a less dense or a more dense material beneath, the surface of the earth would in detail be in a condition of nearly perfect equilibrium, and would largely be free from stresses due to the supporting of topographic features; on the other hand if the compensation is more general such features of moderate extent would be supported by the partial rigidity of the earth's outer materials.

In a recent report[1] Hayford and Bowie study the question of local versus general compensation by a comparison of the residuals, observed minus theoretical gravity, for 41 stations in the United States, and 4 outside. The observations are reduced according to the new method in four different ways: first, with complete local compensation; second, regional compensation for a zone 19 kilometers (12 miles) in radius; third, the same for radius of 59 kilometers (37 miles), and fourth, the same for radius of 167 kilometers (104 miles), this study having been made along these lines at the suggestion of the writer. In the last three reductions the surface layers are taken as rigid to the respective distances from the station, and it is assumed that there is a uniform compensation of the area as a whole. In the last, for instance, an area of the earth's surface of 167 kilometers radius is taken as being in general equilibrium with a uniform compensation beneath this area, but local irregularities as mountains or valleys within this area are assumed to be not locally compensated, but supported rigidly.

The authors state that the resulting evidence "is necessarily slight and possibly inconclusive." In a number of comments, however, it is indicated that the authors favor the idea that the results point to fairly close but not complete local compensation, and finally that "the evidence, slight as it necessarily is, indicates that the assumption of local compensation is nearer the truth than the assumption of regional compensation uniformly distributed to zone 18.8 kilometers."

It is believed that a close scrutiny of the figures does not support this conclusion so far as evidence from these results is concerned. The differences in the mean of the residuals with the four different reductions are insignificant. The suggested advantage for local compensation is based (page 101) on small differences in the relative number of larger and smaller residuals with the respective methods. Along this line, however, it may be noted that of the 41 stations there are only 7 where the local compensation anomaly is lower than any of the three regional, while there are 24 where one of the three regional compensation anomalies is lower than the local. Of the four outside stations three show anomalies in favor of regional compensation. In a later paper by Mr. Bowie under the same title (second paper) a general result is given of an extension of this study to 124 stations in the United States, and it is stated (page 22) that for all these stations "these mean anomalies give only negative evidence," though from a portion of the data he draws a conclusion unfavorable to regional compensation to zone 167 kilometers.

It would seem that the best evidence as to local completeness of compensation from present available observations will be afforded by comparing the residuals at pairs of stations in the same general locality, but differing considerably in elevation, as in such a comparison distant effects and various uncertainties will be largely eliminated, and furthermore it is in such regions that lack of local compensation might be most likely to occur. It is on somewhat the same principle that the most accurate latitude determinations are obtained from observations of pairs of stars. In the 45 stations reduced by the four methods as outlined above there are only five such pairs of stations, that is, stations horizontally not remote, and yet having considerable differences of elevation. The following table gives the facts for these ten stations, and also the differences between the anomalies, subtracting that of the lower from that of the higher station in each instance.

In the second paper there is one more such pair, Cloudland, Tennessee, 1,890 meters, and Hughes, Tennessee, 994 meters, with difference in anomaly for local compensation + .033, subtracting the lower from the higher station; for the three regional compensation reductions (not yet published) the differences are, 19 km. + .031, 59 km. + .031, 167 km. + .031.

[1] "The Effect of Topography and Isostatic Compensation upon the Intensity of Gravity," Coast and Geodetic Survey, 1912.

Station	Elevation, Meters	Difference in Elevation, Meters	Difference in Anomaly, Subtracting Lower from Higher Station			
			Local Compensation, Dynes	Regional Compensation		
				19 Km., Dynes	59 Km., Dynes	167 Km., Dynes
Mauna Kea, Hawaii	3,981					
Honolulu, Hawaii	6	3,975	+.131	+.118	+.105	+.068
Gornergrat, Switzerland	3,016					
St. Maurice, Switzerland	419	2,597	+.046	+.041	+.023	+.016
Pikes Peak, Colorado	4,293					
Colorado Springs, Colorado	1,841	2,452	+.028	+.020	+.016	+.012
Yavapai, Arizona	2,179					
Grand Canyon, Arizona	849	1,330	+.011	+.010	+.010	+.012
Mt. Hamilton, California	1,282					
San Francisco, California	114	1,168	+.020	+.020	+.011	+.029
Mean anomaly difference			.047	.042	.033	.027
Range in anomaly difference			.120	.108	.095	.056

This is too small a number of pairs to warrant a conclusion, but so far as they go, the results show an advantage for regional compensation. Also in every instance the difference is plus on subtracting the anomaly for the lower station from that for the higher, and there is slight indication of a relation to the difference in elevation. The plus difference, if real, indicates an apparent excess of gravity at the high station as compared with the low station. This may be actual and due to some condition of materials beneath the surface, or it may result from a compensation correction relatively too large being applied to the high station, or from some other feature of the reduction. The evidence given by these pairs of stations is slight, but points to the possibility of further interesting investigation, which might be extended along similar lines to a study of differences of deflections at neighboring astronomic stations.

The conclusions from the above are:

1. From the general mass of results there is practically no evidence showing whether there is nearly complete local compensation or only general regional compensation within the areas considered, that is, within zones up to 167 kilometers (104 miles) radius.

2. The comparison of pairs of neighboring stations differing considerably in elevation shows an advantage for regional compensation, but the number of results is too small for a definite conclusion.

3. The comparison by pairs shows in each case gravity at the higher station in excess as compared with gravity at the lower, which if real, may be due to materials beneath the surface, or to some conditions of the reduction. The number of results, five, is, however, too small for safe general conclusions.

4. If practically identical results are obtained with regional and with local compensation or if limited regional compensation is nearer the truth, it may be possible to lessen the labor of reduction of gravity observations by computing the direct topographic effect and the general compensation for a larger zone about the station.

The above discussion bears on one feature only of the interesting reports to which reference is made.

George R. Putnam

Washington, D. C.,
November 13, 1912

SPECIAL ARTICLES

THE VALUE OF THE CILIATE, DIDINIUM, IN THE STUDY OF BIOLOGY

Didinium appears only occasionally in ordinary cultures for the protozoa usually studied in the laboratory. Owing to this fact it is not widely known and consequently its exceptional possibilities as laboratory material for study in courses in biology have been quite generally overlooked. I have had this animal under almost continuous observation during the past four years and have become fairly well acquainted with it. The following notes are based upon these observations.

Didinia feed largely on paramecia. They

multiply more rapidly than paramecia, so that if they are introduced in a culture they soon devour all of their food, after which they ordinarily encyst. In this state they can be kept indefinitely and when wanted for study all that is necessary is to add, a few days in advance, a vigorous culture of paramecia. After the addition of this culture some didinia usually come out within twenty-four hours, but I have found it necessary in some instances to wait several days. They seldom come out in every culture containing cysts, so that it is wise always to keep a number on hand. I have found 50 to 100 c.c. wide-mouthed bottles most satisfactory for this purpose. On several occasions I left culture jars containing cysts together with considerable débris uncovered during the summer vacation and found in the autumn, at least two months after all of the water had evaporated that the cysts came out in about half of the jars. I am, however, of the opinion that the cysts keep better if the liquid is not allowed to dry. On one occasion I kept cysts for very nearly a year[1] in a 5 c.c. bottle full of solution hermetically sealed and found numerous active didinia in less than twenty-four hours after adding a solution containing paramecia. Thus it is evident that after a culture is once established material can be obtained in abundance at any time.

Didinium is usually described as a barrel-shaped organism. It has two bands of cilia, one near the anterior end, which contains a cone-shaped protuberance with the mouth at the apex, the other near the posterior end where the contractile vacuole is located. The so-called seizing organ, a strand of fibrous tissue, extends from the central part of the body to the mouth. The macronucleus is a comparatively large and conspicuous horseshoe-shaped structure. All of these characteristic features can be clearly seen in specimens killed in Worcester's fluid (a saturated solution of corrosive sublimate in ten per cent. formalin containing a little acetic acid) and cleared by adding a very small proportion of ten per cent. glycerine and allowing it to concentrate slowly by evaporation. They can also be seen fairly distinctly in living specimens which have been kept for a day without food, especially if they are held stationary and slightly flattened under the cover-glass. This can be done readily by slowly removing the water by means of a bit of filter paper. If the cover-glass is slightly tapped after the animals are flattened they burst and then the protoplasmic contents flow out. The ectosarc is rather tough and remains intact for some time, resembling a shell. The seizing organ usually breaks up and the numerous fibers of which it is composed separate and flow about in the liquid so that they can be clearly seen. The macronucleus rarely breaks and if the cover-glass is lightly touched at ried about in the more liquid cytoplasm and rolls over and over, presenting a view from all sides. In this way the student gets an exceptionally realistic idea of it as a definite structure having a strikingly different consistency from that of the cytoplasm.

The greatest value of *Didinium,* however, in the study of biology lies in the intense interest aroused by the observation of the remarkable phenomenon of feeding. I have repeatedly seen one of these organisms capture and swallow entire in the course of several seconds a paramecium ten times its own size. And the essentials in this process can readily be observed by almost any student.

I should recommend two different methods in making these observations.

1. Place a good number of didinia which have been without food for a day in a shallow watch-glass or on a slide and then while observing under the low power, add a drop of solution containing numerous paramecia. Or if more details are desired make on a slide, with a small ridge of vaseline, an enclosure somewhat smaller than a cover-glass. The enclosure should have a small opening on one side. Put a large number of hungry didinia

[1] Since writing this I obtained a good number of active didinia from cysts which had been in a 5 c.c. vial full of solution two years and four months.

in the enclosure, cover them with the cover-glass, place a drop of solution containing paramecia at the opening in the enclosure, and then study the process of feeding under low or high power at the place where the two solutions meet. Didinia thus enclosed can be studied for hours without danger from drying and if put into a damp chamber when not in use they can often be kept for days. This is an excellent method for observation on all sorts of protozoa.

2. A few seconds after adding paramecia to a solution containing many didinia kill them suddenly by flooding the dish with a liberal supply of Worcester's fluid. If the animals are killed at just the right time specimens in all stages of the process of feeding will be found. These can be mounted and studied at leisure under any magnification desired. If the animals are treated with glycerine as described above the different structures stand out very distinctly. I used this method in demonstrating the protective function of the trichocysts. In order to do this it is, however, necessary to have relatively large paramecia and small didinia.

Another very interesting and instructive process that can be observed readily in *Didinium* is encystment. Although this is a protective process of the greatest importance in many organisms, it is rarely studied first hand. Didinia can be induced to encyst almost any time by cutting off the food supply and adding considerable decaying organic matter, and as previously stated they can be induced to develop and become active again by adding a strong culture of paramecia. Different stages in these processes can frequently be seen, as for example the disappearance of the cilia, mouth seizing-organ, macronucleus, etc.

Conjugation occurs abundantly at times in *Didinium,* but the environmental factors necessary to induce it have not as yet been ascertained with sufficient accuracy to make this form at all favorable for the study of this process. Fission, on the other hand, occurs more frequently than in *Paramecium* and many other protozoa and the essential features in the process are easily worked out.

It seems to me then that owing to the readiness with which *Didinium* can be procured at any time, the ease with which its structures can be worked out, and the possibility of observing the phenomena of fission and encystment and especially the marvelous process of feeding, this animal should become as familiar in biological laboratories as *Paramecium* now is. In fact, the study of *Paramecium* must be regarded as very superficial indeed without observations on *Didinium* and its method of protection against this deadly enemy.

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S. O. Mast
Johns Hopkins University

THE NUMBERS OF INSECTS DESTROYED BY WESTERN MEDDOWLARKS (STURNELLA NEGLECTA)

Little definite data as to the exact numbers of insects destroyed by birds in a given locality has as yet been available. In connection with an investigation into the food habits of certain California birds now being carried on by the California State Board of Fish and Game Commissioners, and the University of California, considerable evidence as to the toll of insects taken by certain species of birds is being made available. With the help of the deputies of the commission it has been possible to collect birds in sufficient quantities for stomach examination, in some twenty different parts of the state, and in every month of the year. A knowledge of the food habits of the birds throughout the year is therefore at hand.

The western meadowlark (*Sturnella neglecta*) has been the subject of considerable complaint from the ranchers of the state, owing to its habit of pulling sprouting grain. The investigation has shown that this bird is guilty of destroying sprouting grain; but the evidence as to its value as a destroyer of insects is of greater interest. Some idea of the remarkable change of food habits during the year can be obtained from the following table.

COMPARISON OF THE FOOD HABITS OF THE MEADOWLARK FOR DIFFERENT MONTHS OF THE YEAR, 1911

Birds Collected in Grain Fields in the Vicinity of Red Bluff, Tehama County, Cal. Average of Six Birds for Each Month

Month	Per Cent. Animal Food	Per Cent. Vegetable Food	Per Cent. Beetles	Per Cent. Cutworms	Per Cent. Grain	Per Cent. Grasshoppers
January....	1.0	99.0	1.0		94	
February...	38.5	61.5	3.6	31.0	41.6	
March.....	87.2	12.8	22.7	20.6	10.6	
April......	73.6	26.4	5.2	51.0		
May.......	99.9	.1	6.2	69.0		4
June.......	96.5	3.5	3.0	15.0		57.5
July.......	91.3	8.7	4.7		6.3	85.5
August.....	75.2	24.8	2.1		15.6	72.6
September..	88.0	12.0	7.8	3.2		61.2
October....	37.5	62.5	.5		47.1	35.6
November..	28.4	71.6	14.0	14.1	38.1	
December..	57.6	42.4	18.6	15.8	13.0	
Avs. for year	64.6	35.4	7.6	18.3	22.2	26.4

Grain appears to be resorted to when insects are not available. Beetles are taken the year round. Cutworms in the food reach a maximum in May, whereas grasshoppers reach a maximum in July, in this particular locality. A table showing the numbers of cutworms actually counted in the stomachs of meadowlarks taken at Red Bluff in February, March, April, May and June, and their per cent. of volume demonstrates the quantities of these pests destroyed by this species of bird. It will be noted that the numbers of cutworms consumed is greater when the worms are still of small size. The percentages represent the comparative volume of the different kinds of food found in the stomach. A few larvæ not typical cutworms, taken by the birds, are nevertheless classified under this heading.

TABLE SHOWING NUMBERS AND PERCENTAGES OF CUTWORMS CONSUMED BY MEADOWLARKS TAKEN IN THE VICINITY OF RED BLUFF, CAL.

1911	No. of Birds	No. of Cutworms	Per Cent. of Cutworms
February....	12	360	36.8
March......	12	16	22.5
April.......	12	68	41.9
May........	12	90	44.7
June........	6	6	9.1
Totals......	54	540	Av. 31.0

The value of meadowlarks as checks on the increase of grasshoppers is also attested by the accompanying table.

TABLE SHOWING NUMBERS AND PERCENTAGES OF GRASSHOPPERS CONSUMED BY MEADOWLARKS TAKEN IN THE VICINITY OF EL TORO, CAL.

1911	Number of Birds	Number of Grasshoppers	Average Number of Grasshoppers	Average Per Cent. of Grasshoppers
June............	13	53	4	43.2
July............	7	59	8.4	77.5
August..........	19	314	16.5	93.89
September.......	6	75	12.5	96.3
October.........	13	122	9.3	61.9
November.......	8	115	14.3	66.6
Totals and avs...	66	738	10.1	73.23

The numbers of grasshoppers were estimated by counting paired mandibles. Mandibles pass through the alimentary tract without being digested, as can be shown by an examination of the feces. Experiments with young meadowlarks has shown the time of digestion of grasshoppers to be between three and four hours. The numbers found in stomach examination doubtless represent, therefore, those which have been eaten during the preceding three or four hours, before the birds were killed. In order to ascertain some idea of the numbers consumed in a day, the average number per bird needs to be multiplied by four. It seems safe to conclude that the particular meadowlarks examined were averaging almost fifty grasshoppers a day. As many as twenty-eight pairs of mandibles were found in a single stomach.

Of course not all of the grasshoppers destroyed can be considered injurious, for only certain species become abundant enough to destroy crops. The main point to be noted is that birds, if they feed on insects to the extent shown in this instance, must play a much more important part as checks on the numbers of insects than many people have hitherto believed.

Stomach examination has shown that a considerable percentage of the food of the western meadowlark is made up of ground beetles, these insects being eaten every month of the year. The harm done in destroying beetles considered beneficial because of their predacious habits (*e. g., Calosoma*) is in a large measure counteracted by the destruction of certain injurious elaterid (*e. g., D. rasterius*) and chrysomelid (*e. g., Diabrotica soror*) beetles. The stomach of a meadowlark taken at Big Pine, Inyo County, California, November 20, 1911, contained over thirty-six chrysomelid beetles of the species *Diabrotica soror*. In that this species is very destructive in the state, and as insecticides are seldom used as a means of control, any natural means of check becomes of importance, and should be so recognized.

A knowledge of the part played by certain birds in the economy of nature is yearly becoming more important and demands attention, lest the information needed be forthcoming too late. As the fairest test of the value of a bird is dependent on a knowledge of its food habits, the investigation in hand will help to demonstrate the economic value of those birds now considered of doubtful value. The investigation will not stop with a knowledge of the food habits alone, for the life history of each bird and its relation to its environment constitute factors almost as important, which must be considered. The justification of the investigation does not only lie in the increased information as to the food of birds, but in the saner protection which must necessarily follow the knowledge of the use of birds.

Harold C. Bryant,
Assistant, California State Fish and Game Commission
Zoological Laboratory,
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Berkeley, California

THE MOSAIC DISEASE OF TOBACCO

During the past winter an investigation of the Mosaic disease of tobacco was undertaken by the writer. Mosaic has been generally regarded as a so-called physiological disease and it was planned to carry out the investigation along physiological lines. However, certain observations soon brought to light new facts which would seem to throw considerable doubt on former views as to the nature of the malady. It was found that insects are involved in the dissemination of the disease and the Bureau of Entomology has undertaken to follow up this phase of the problem. It will doubtless require considerable time to work out satisfactorily the questions involved, but it is thought desirable to announce the more important facts which have been established regarding this obscure disease.

Susceptibility of other Solanaceous Plants to the Mosaic Disease

Heretofore, no investigator has shown definitely that the mosaic disease of tobacco is communicable to other plants. The writer, however, has readily transferred the disease from tobacco to a great variety of solanaceous plants. By inoculation the disease has been obtained in plants of the following genera: *Nicotiana, Lycopersicon, Petunia, Physalis, Datura, Hyoscyamus, Solanum* and *Capsicum*. A mosaic plant of the species (*Solanum carolinense*) brought to the writer's attention, indicates that the mosaic disease of tobacco sometimes occurs in strictly wild plants.

Efforts to inoculate the common potato (*Solanum tuberosum*), the eggplant (*Solanum melongena*) and belladonna (*Atropa belladonna*) were without success. Among the species of *Nicotiana*, it has not yet been possible to develop the disease in the species *N. glauca* and *N. viscosum*.

Appearance of the Blossoms of Mosaic Tobacco Plants

The development of mosaic in all varieties of *Nicotiana tabacum* usually affects the intensity and distribution of the pink coloration of the corollas in much the same manner that it affects the intensity and distribution of the green color of the leaves. For this reason an examination of the blossoms often affords one of the surest indications of the presence of mosaic in a tobacco plant. So far as the writer is aware, this distinctive appearance of the blossoms has not before been mentioned.

Specific Infection Apparently Responsible for the Development of Mosaic

The writer's experiments do not bear out the conclusions of earlier investigators that a true, infectious mosaic can be produced in plants by simply cutting them back.

If the infectious principle of mosaic is not accidentally introduced during the course of the experiments, and if the plants are absolutely free from the disease at the time of cutting, our experiments indicate that these plants may be cut back indefinitely without producing mosaic. Healthy plants have been constantly cut back, in some instances for long periods, without producing any symptoms of true mosaic. This was not accomplished, however, until thorough methods of sterilizing were observed, and the plants had been carefully screened and fumigated to exclude aphids.

Soil Infection

All experimental data at hand indicate that soil infection is not as important a factor as has been supposed in the origin of mosaic in the seed bed. In many experiments it has been shown beyond question that an outbreak of mosaic in young plants was not in any way connected with soil infection.

Aphids as Carriers of the Mosaic Disease

In the course of the writer's greenhouse experiments with tobacco, it was observed that the occurrence of mosaic in plants at various stages of development was in some manner frequently associated with aphid infestation.

Under control conditions it was observed that healthy tobacco plants were always obtained if these were grown in screened cages fumigated at short intervals to prevent aphid infestation. On the other hand, when colonies of aphids present in the greenhouse were introduced into other cages containing healthy plants, infestation of the plants resulted in a wholesale occurrence of mosaic. This phase of the question has been taken up in cooperation with the Bureau of Entomology.

Following inoculation a somewhat variable inoculation period preceded the first symptoms of mosaic. This period and the subsequent symptoms appear to be practically the same in whatever manner the disease may be communicated to healthy plants.

In the light of the facts brought out in our experiments, it is not easy to see how the mosaic disease of tobacco can be logically placed in the category of purely physiological diseases. These facts strongly suggest the presence of a living, active microorganism.

It has been suggested at various times that the pollen grains may be the carriers of a mosaic disease. Earlier investigators have shown (and the writer has substantiated these results) that the seed of mosaic plants produces healthy plants. As a matter of fact, the general rule of self-fertilization of the tobacco flower means that the pollen grain and ovules are both produced by a mosaic plant. These facts are not favorable to the pollen-grain transmission of the disease.

H. A. Allard
Bureau of Plant Industry,
Washington, D. C.

THE CONVOCATION WEEK MEETING OF SCIENTIFIC SOCIETIES

The American Association for the Advancement of Science and the national scientific societies named below will meet at Cleveland, Ohio, during convocation week, beginning on December 30, 1912.

American Association for the Advancement of Science.—President, Professor Edward C. Pickering, Harvard College Observatory; retiring president, Professor Charles E. Bessey, University of Nebraska; permanent secretary, Dr. L. O. Howard, Smithsonian Institution, Washington, D. C.; general secretary, Professor H. E. Summers, State College, Ames, Ia.; secretary of the council, Professor H. W. Springsteen, Western Reserve University, Cleveland, Ohio.

Section A—Mathematics and Astronomy.—Vice-president, Professor E. B. Van Vleck, University of Wisconsin; secretary, Professor George A. Miller, University of Illinois, Urbana, Ill.

Section B—Physics.—Vice-president, Professor Arthur Gordon Webster, Clark University; secretary, Dr. W. J. Humphreys, Mount Weather, Va.

Section C—Chemistry.—Vice-president, Professor W. Lash Miller, University of Toronto; secretary, Professor C. H. Herty, University of North Carolina, Chapel Hill, N. C.

Section D—Mechanical Science and Engineering.—Vice-president, Dr. J. A. Holmes, U. S. Reclamation Service; secretary, G. W. Bissell, Michigan Agricultural College, East Lansing, Mich.

Section E—Geology and Geography.—Vice-president, Professor James E. Todd, University of Kansas; secretary, Professor George F. Kay, University of Iowa.

Section F—Zoology.—Vice-president, Professor William A. Locy, Northwestern University; secretary, Professor Maurice A. Bigelow, Teachers College, Columbia University, New York City.

Section G—Botany.—Vice-president, Professor D. S. Johnson, The Johns Hopkins University; secretary, Professor Henry C. Cowles, University of Chicago, Chicago, Ill.

Section H—Anthropology and Psychology.—Vice-president, Dr. J. Walter Fewkes, Bureau of American Ethnology; secretary, Professor George Grant MacCurdy, Yale University, New Haven, Conn.

Section I—Social and Economic Science.—Vice-president, John Hays Hammond, New York City; secretary, Seymour C. Loomis, 69 Church St., New Haven, Conn.

Section K—Physiology and Experimental Medicine.—Vice-president, Professor J. J. McCleod, Western Reserve University; secretary, Professor George T. Kemp, 8 West 25th St., Baltimore, Md.

Section L—Education.—Vice-president, Professor J. McKeen Cattell, Columbia University; secretary, Professor C. Riborg Mann, University of Chicago, Chicago, Ill.

The Astronomical and Astrophysical Society of America.—December 30–January 4. President, Professor E. C. Pickering, Harvard College Observatory; secretary, Professor Philip Fox, Dearborn Observatory, Evanston, Ill.

The American Mathematical Society.—December 31–January 2. President, Professor H. B. Fine, Princeton University; secretary, Professor F. N. Cole, 501 West 116th Street, New York City.

The American Federation of Teachers of the Mathematical and the Natural Sciences.—Between December 30–January 4. President, Professor C. R. Mann, University of Chicago; secretary, Eugene Randolph Smith, The Park School, Baltimore, Md.

The American Physical Society.—President, Professor W. F. Magie, Princeton University; secretary, Professor Ernest Merritt, Cornell University, Ithaca, N. Y.

The American Society of Biological Chemists.—December 30–January 1. President, Professor A. B. Macallum, University of Toronto; secretary, Professor A. N. Richards, University of Pennsylvania, Philadelphia, Pa.

The American Physiological Society.—December 30–January 1. President, Dr. S. J. Meltzer, Rockefeller Institute for Medical Research, New York City; secretary, Professor A. J. Carlson, University of Chicago, Chicago, Ill.

The Society for Pharmacology and Experimental Therapeutics.—December 30–31. President, Professor John J. Abel, The Johns Hopkins University; secretary, Dr. John Auer, Rockefeller Institute for Medical Research, New York City.

The American Society of Naturalists.—January 2. President, Professor E. G. Conklin, Princeton University; secretary, Professor A. L. Treadwell, Vassar College, Poughkeepsie, N. Y.

The American Society of Zoologists.—December 30–January 1. *Eastern Branch:* President, Dr. A. G. Meyer, Tortugas, Fla.; secretary, Professor J. H. Gerould, Dartmouth College. *Central Branch* (in charge of meeting): president, Professor H. B. Ward, University of Nebraska; secretary, Professor W. C. Curtis, University of Missouri, Columbia, Mo.

The Association of American Anatomists.—December 31–January 2. President, Professor Ross G. Harrison, Yale University; secretary, Professor G. Carl Huber, 1330 Hill Street, Ann Arbor, Mich.

The Entomological Society of America.—December 31–January 1. President, Professor Stephen A. Forbes, University of Illinois; secretary, Professor Alexander D. MacGillivray, 603 West Michigan Ave., Urbana, Ill.

The American Association of Economic Entomologists.—January 1–3. President, W. D. Hunter, Dallas, Tex.; secretary, A. F. Burgess, Melrose Highlands, Mass.

The American Microscopical Society.—December 31–January 1. President, Dr. F. D. Heald, Philadelphia; secretary, T. W. Galloway, Millikin University, Decatur, Ill.

The Botanical Society of America.—December 31–January 3. President, Professor L. R. Jones, University of Wisconsin; secretary, Dr. George T. Moore, Botanical Garden, St. Louis, Mo.

Botanists of the Central States.—Between December 30 and January 4. President, Professor T. H. Macbride, University of Iowa; secretary, Professor Henry C. Cowles, University of Chicago, Chicago, Ill.

The American Phytopathological Society.—December 31–January 3. President, Dr. G. P. Clinton, New Haven Agricultural Experiment Station; secretary, Dr. C. L. Shear, Department of Agriculture, Washington, D. C.

The American Nature-Study Society.—December 30–31. President, Professor Benjamin M. Davis, Miami University; secretary, Dr. Elliot R. Downing, University of Chicago, Chicago, Ill.

The Association of Official Seed Analysts.—January 2. President, Dr. E. H. Jenkins, New Haven, Conn.; secretary, E. Brown, U. S. Department of Agriculture, Washington, D. C.

American Association of Official Horticultural Inspectors.—January 2–3. President, Dr. T. J. Headley, New Brunswick, N. J.; secretary, T. B. Symons, College Park, Md.

The American Anthropological Association.—December 30–January 3. President, Dr. J. Walter Fewkes, Bureau of Ethnology; secretary, Professor George Grant MacCurdy, Yale University, New Haven, Conn.

The American Folk-Lore Society.—January 1. President, John A. Lomax, University of Texas; secretary, Dr. Charles Peabody, Peabody Museum, Cambridge, Mass.

The American Psychological Association.—December 30–January 1. President, Professor Edward L. Thorndike, Columbia University; secretary, W. Van Dyke Bingham, Dartmouth College, Hanover, N. H.

The Sigma Xi Convention.—January 2. President, Professor Henry T. Eddy, University of Minnesota; secretary, Dr. Dayton C. Miller, Case School of Applied Science, Cleveland, Ohio.

Gamma Alpha Graduate Scientific Fraternity.—December 31. President, Professor William Crocker, University of Chicago; secretary, Professor H. E. Howe, Randolph-Macon College, Ashland, Va.

NEW HAVEN

The Geological Society of America.—December 28–31. President, Professor H. L. Fairchild, Rochester University; secretary, Dr. Edmund Otis Hovey, American Museum of Natural History, New York City.

The Association of American Geographers.—December 27–30. President, Professor Rollin D. Salisbury, University of Chicago; secretary, Professor Albert Perry Brigham, Hamilton, N. Y.

The Paleontological Society.—December 30–31. President, David White, U. S. Geological Survey; secretary, Dr. R. S. Bassler, U. S. National Museum, Washington, D. C.

BOSTON

The American Economic Association.—December 27–31. President, Professor Frank A. Fetter, Princeton University; secretary, Professor T. N. Carver, Harvard University, Cambridge, Mass.

The American Statistical Association.—December 27–30. President, Professor Walter F. Willcox, Cornell University; secretary, Carroll W. Doten, 491 Boylston Street, Boston, Mass.

The American Sociological Society.—December 27–31. President, Professor Albion W. Small, University of Chicago; secretary, Scott E. W. Bedford, University of Chicago, Chicago, Ill.

The American Association for Labor Legislation.—December 27–28. President, Professor Henry R. Seager, Columbia University; secretary, Dr. John B. Andrews, 131 East 23d St., New York City.

The American Home Economics Association.—December 30–31. President, Miss Isabel Bevier, University of Illinois; secretary, Benjamin R. Andrews, Teachers College, Columbia University, New York City.

NEW YORK CITY

The Society of American Bacteriologists.—December 31–January 2. President, Dr. Wm. H. Park, New York City; secretary, Charles E. Marshall, Amherst, Mass.

SCIENCE

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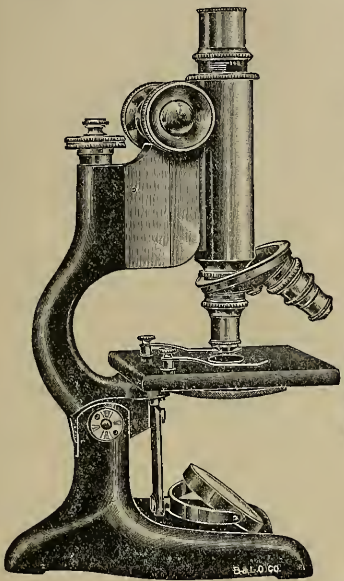

SCIENCE

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CONTENTS

MSS. intended for publication and books, etc., intended for review should be sent to Professor J. McKeen Cattell, Garrison-on-Hudson, N. Y.

THE ARTIFICIAL RIPENING OF BITTER FRUITS[1]

This subject has been chosen not only because of a certain intrinsic interest which I trust will presently be admitted, but because also it serves to illustrate the important contention that the problems of pure and applied science go back for their solution to the same fundamental principles. It is true that empiricism has solved, in a measure, many practical problems, and that, indeed, science has grown out of empiricism. But science in her turn leads more rapidly and surely to the goal which is sought, for the simple reason that she explains why things happen as they do. For a single and almost overworked example, the ancients knew that peas and clovers enriched the soil, and this knowledge led to the practise of rotation in the planting of crops. But it is very recent knowledge that this behavior is due to the peculiar relations of certain bacteria to a limited group of the higher plants known collectively as the legumes, by which the free nitrogen of the air is made available to the latter. The economic salvation of immense areas, yet to be accomplished, may now be compassed with this knowledge—a very practical outcome. On the other hand, the understanding of the nitrogen relations of plants has stimulated the chemist to discover a method, and if possible an economical method, of fixing atmospheric nitrogen, so that this vast storehouse of material may be rendered more available, the solution of which problem could not by any chance have been attained except by

[1] The university lecture, October 8, 1912.

the application of highly theoretical knowledge.

A further, but less widely appreciated, example of the same thing is afforded by the present subject, namely, the control of the certain ripening processes in bitter, or rather astringent fruits. We shall see, as the details are unfolded, that here too empiricism has preceded science, but that science is at the moment endeavoring to explain experience, with the result that, while problems of very great practical importance are being solved, new facts of still greater theoretical weight are being discovered.

Astringency in fruits and other plant parts is due to the presence of tannin in some form, very frequently tannic acid. It will suffice here to speak of it simply as tannin. Certain kinds of bark and other parts of many plants contain this substance in such quantities that they are used for the tanning of hides and for the extraction of tannin for other purposes, some of which are medicinal. The usefulness of tannin in the arts depends on its peculiar property of being able to enter into combination with many other substances, such as proteins, gelatins, mucilages and the like, to form complexes (or compounds in a loose sense) which have in common the peculiar property of resisting agents of decay. This fact is perfectly well known and tannin has been made use of since time immemorial as a preservative of material exposed to conditions favorable to decay, such as sails, fishing tackle and the like.

But if one wishes to have a more vivid impression of this peculiarity of tannin seen in its ready combination with colloidal materials, one needs but to take into the mouth a few drops of a solution of tannin, or to bite into an astringent fruit, such as the persimmon, or an unripe banana. The tannin in these will quickly attack and combine with the skin of the mouth, and produce the drawing or puckering effect familiar to all. The same experience is had on drinking tea which has been too long standing. What happens in the mouth may be accurately and simply described as a rapid manufacture of a thin coating of leather over the mucous membranes.

Another peculiarity of these tannin complexes, such as leather and the like which it is necessary to mention briefly, is this, namely, that one may easily extract with water a certain amount of the tannin without any obvious change in the physical character of the complex. If we soak leather in water, we can show that some of the tannin has come out. We may do this repeatedly, and always get some but again always, a decreasing amount of tannin. An analogous example is afforded by certain dyes which stain the cotton fiber but which may be extracted in repeatedly diminishing quantities by water. Such complexes are said to arise by adsorption; they are not, at any rate, chemical compounds in the ordinary sense. In this connection our attention should be drawn to another fact of prime importance in what follows. It is that dyes are held more tenaciously by coagulable substances, such as the white of egg, when they are in a state of coagulation than when not, so that, given a certain amount of dye and a certain amount of the albumin (or whatever other substance may be used), a less amount of the dye can be extracted by water if the albumin has been coagulated by heat—as happens when an egg is cooked—than otherwise. I have shown that tannin in its relation with a coagulable substance in the persimmon, analogous to the white of egg, acts in the same way. The significance of this in relation to non-astringency of fruits will be indicated as we proceed.

The term colloid has already been used.

Inasmuch as the living body, whether of the plant or of the animal, is made up, aside from the water content, very largely of colloids, I must venture, at the risk of appearing to dwell overmuch upon very elementary matters, to draw attention to certain of their characteristics. In negative fashion, a colloid may be described as a substance which does not crystallize, and this feature serves to contrast it with other substances, such as salts, sugars, etc., which, upon going out of solution, assume geometrical forms. It is more difficult to define colloid in positive terms, but fortunately we are all of us familiar enough with them so that we do not need a formal description. Glue, gelatin, mucilage are examples. Tannin, which claims our especial notice at this time, is also a colloid. When colloids are dissolved in water, they break up into particles which are far too small to be seen with the naked eye, but which are very much larger than the particles in a solution of a crystalloid. These may be identical with the molecules, or still smaller, when they represent the ions, or grosser components of the molecule small beyond even the strongest powers of the microscope. Colloids, however, in many cases, may in their dissolved condition be seen by means of the ultramicroscope, when they appear as minute brilliantly illuminated particles (suspensoids). One may understand this by recalling that a very small mirror at a great distance can be seen when it is caused to reflect the sunlight into the eye of the observer. The ultramicroscope therefore enables us in many instances to see what goes on in solutions of colloids. For example, it makes it possible to watch the process of coagulation in those colloids in which coagulation is possible. Thus, if we examine a weak casein solution—we can make such by thinning skimmed milk with water—we see a very pandemonium of dancing illumined particles. These remain in constant motion, flying hither and yon at a rate of speed too great to follow with the eye. If now we add a minute amount of an acid, the particles may be observed to hit one another and to remain in contact, so forming a continuous mass or apparently continuous, since we know that water is held within the coagulum. Quite similar appearances may be had by adding a solution of tannin to one of gelatin.

If, however, before adding acid to the casein solution, we add a little mucilage, the coagulation may be prevented. This illustrates the principle of colloidal protection—in this instance the mucilage protects the casein from the action of the acid. I have shown that a similar relation exists between tannin and mucilage as against alkaloids. Tannin immediately precipitates an alkaloid, such as antipyrin, in solution in water. When, however, a mucilage has previously been added, the precipitation is prevented. If, therefore, on adding an alkaloid to a solution of tannin we get no precipitate, we must argue that there is a third substance present which protects the tannin. Such a condition will be shown to occur in the fruits with which we concern ourselves to-day.

We now turn to examine typical examples of fruits which, before entering the condition regarded as edible, are highly astringent, but which, when "ripe," appear to be entirely devoid of the astringent principle, tannin. I use this wording advisedly, since the fact is that such fruits contain quite as much tannin when non-astringent as before. What has become of the tannin I propose to show you. The examples in question are the date of Arabia and Africa, the staple food product of the Arab, and the persimmons of eastern Asia and of North America.

The fruit of the date palm is hard, green and highly astringent, the approximately oval shape and the size varying in the different varieties, of which there are many. When ripe they may be dry or very soft and syrupy, again according to the variety. The soft dates when ripe can not be transported unless they are dried and packed, and it is in this condition that we are familiar with this fruit. In order to market the soft varieties so that they may be consumed in the fresh condition, the Arabs have practised for many centuries the art of artificial ripening. This consists in exposing the bunches of unripe fruit to the vapors of vinegar, of which the active agent appears to be the acetic acid, judging from the experiments of Vinson, of the Arizona Agricultural Experiment Station. Among other changes which take place during the artificially induced ripening period, the most obvious is the rapid disappearance of astringency, so that the quite inedible fruit of to-day is ready to the palate on the morrow or at latest the following day. Vinson further found that there is a great variety of chemicals which can produce the same result; so various in kind indeed are the chemicals that the changes in the fruit can not be explained as ordinary chemical reactions. Supranormal temperatures up to 70 degrees Fahr. may also be used, but higher temperatures kill the fruit, after which it is impossible to render them non-astringent. There is, however, a distinction to be drawn at this point between the effects of certain ripening agents and others. Thus, when some chemical substances, such as acetic acid, nitrous ether, etc., are used, the tannin changes from being colorless to red, indicating that it has been oxidized. Oxidized tannin is tasteless, so that in such case the non-astringency is readily explained. If heat or alcohol be used, the tannin remains colorless, and as such is astringent, so that, if it can not be detected by the tongue, this is the result of some other condition than oxidation. Indeed the evidence is well nigh conclusive that during the ripening of the date the tannin remains unchanged chemically, but that its collophysical relations have been changed. That it is still present may at once be demonstrated by the use of suitable chemical reagents—their suitability depending on whether the reaction produces a color change or not. Thus the salts of iron and other metals produce the corresponding color changes; alkaloids produce no change. It has been pointed out before, however, that the reaction of alkaloids and tannin may be prevented by means of a protector and this leads us to the conclusion that non-astringency in the ripe date is due not to the destruction of the tannin or to any chemical change in it, but to the presence of an efficient protector. Further evidence for this will be given further on.

The persimmon occurs wild as a single recognized species in North America, and the fruit is known in the south as the "'possum persimmon" for the reason that the opossum fattens on it in the autumn. In China and Japan there are numerous cultural varieties, most of which resemble a ripe tomato in size, shape and color. Certain kinds lose their astringency before they soften, and can be eaten as we eat apples, biting into a firm flesh. Others become edible only after becoming quite soft and watery, so that a spoon becomes an appropriate implement for managing them. Still another kind, described as an "astringent variety" is used as the source of a fluid, called *"kaki-no-shibu,"* obtained by mashing up the fruits in water and allowing the mash to ferment. The product is used for waterproofing fishing lines and nets, and for coating wrapping paper,

paper umbrellas and similar services[2]—examples of the preserving effect of tannin. The peculiar properties of kaki-no-shibu, however, as the Japanese chemist Ishikawa suspected years ago, is not due to the tannin content alone, but to the joint action, as I believe, of the tannin and another substance of mucilage-like character with which the tannin is combined much as it is with hide to make leather.

We are concerned here, however, with those edible sorts which do not become non-astringent without at the same time softening. These when quite ripe can only by courtesy be called edible—decayed would better describe their condition. They have lost a fine aroma and a delicate sweetness which, coupled with a crisp firmness, would, in the absence of tannin, make up the qualities of a delicious fruit, as those know who have eaten them after being ripened artificially either in Japan or at home. This is accomplished by the Japanese, as it has been for centuries doubtless, by packing the hard, unripe fruit in freshly emptied tubs, in which sakè, the national whisky of that people, has been kept. A fully packed tub is tightly closed and the contained air in them displaced[3] by blowing through a small hole, the air escaping by another. The openings are then plugged so that the package is made air-tight. In the course of a few days, the length of time depending upon the variety under process, the fruit becomes edible without losing its firmness. This hastening of one of several independent processes, spoken of collectively as ripening, resulting in non-astringency, has been regarded as due to the action of some constituent of the sakè, with which the wood of the cask is of course soaked. This may be either the alcohol or a slight amount of acetic acid. I have argued, from experimental data, that it is the alcohol which, by stimulating the fruit to respiration in excess of the normal, quickly causes a formation of carbonic acid gas in addition to that which is introduced by the breath. At any rate, there is little doubt that the carbonic acid gas is the active agent, since Gore, of the Bureau of Chemistry, U. S. Department of Agriculture, found that certain varieties of persimmons grown in the United States could be treated with carbon dioxide at normal pressure with results quite similar to those obtained by the Japanese with their ancient but empirical method. Gore's experiments were in part repeated by myself at the State Experiment Station of Alabama, with like outcome. It was found that the variety known as *Hyakume*[4] grown on the station grounds if exposed for about eight days to an atmosphere of pure carbon dioxide, loses its bitterness while still remaining firm and crisp, and retaining its aroma and sweetness. The fruit so treated was most excellent to the taste, as testified to by a number of persons whose skepticism regarding the edibility of a hard persimmon had been begotten of much experience, and whose testimony was therefore of the greater value.

At this point a question arose. If a pure atmosphere of carbon dioxide at ordinary pressure induces the already described result, why should not an increased dosage effect the same result more rapidly? To attain to the answer I exposed the same variety of fruit to twice the amount of the

[2] Bishop Heber Hamilton informs me that kaki-no-shibu is used also for painting exposed woodwork, but is efficient only for a year. When applied it is colorless, but turns red in a few days—evidently by oxidation of the tannin.

[3] According to some accounts, this is done when reclosing the package after it has been opened to test the fruit.

[4] There are two varieties of Hyakume recognized, one of which is astringent until softening intervenes, while the other loses its astringency while still firm.

gas by using a metal tank which would maintain the required pressure. Into this was forced the gas to an indicated pressure of 15 pounds, which means that two volumes of the gas were compressed into the enclosed space of the apparatus. Under these conditions the fruit became quite edible in less than 46 hours. That is, the time required to render the fruit non-astringent under normal atmospheric pressure was reduced to one fourth that time, or rather less, as it later appeared, by increasing the pressure twice. This was in the autumn of 1911, at the time when no further experiments were possible. During the early part of September, 1912, the experimentation with supranormal pressures was renewed. A special apparatus had already been devised, composed of a piece of four-inch gas pipe, suitably capped, and supplied with a pressure gauge and with outlets guarded by gas cocks. This device enabled me to try the effects of pressure reaching up to 90 pounds, or seven times the original dosage. It is interesting to note that this high pressure kills the fruit in a few hours, so that it becomes watery and unattractive. It is nevertheless non-astringent. The effect, however, of 45 and of 15 pounds pressure separately were determined with considerable accuracy, with the following result. The fruit exposed to 15 pounds pressure became non-astringent in about 36 hours; that subjected to 45 pounds in about 15 hours. We may say, therefore, that, as the pressure of the carbon dioxid increases, the period of time required for causing the apparent disappearance of the tannin is decreased, and that the pressure goes up much less rapidly than the period is decreased. To make assurance doubly sure, the fruits which were used in the experiment which I have just briefly summarized ranged in degree of maturity from being entirely green, of the green of grass, to orange-yellow, the next to final color stage of ripening, and it eventuated that fruits which are entirely green can be rendered non-astringent in scarcely less time than those much nearer maturity, thus leaving no doubt of the significance of the experiments. To state these results in everyday terms of practical economics, we can say that it is now possible to ship, say on September first, green or near-green persimmons of the variety mentioned from Alabama to Montreal, where they should arrive in good condition, hard and without bruise or other blemish, on September third. Being, however, quite inedible, and with a prospect of remaining so for a month, or even longer, if kept in cold storage, the fruit is placed in a very simple and cheap apparatus, and subjected to 45 pounds pressure of carbon dioxid. The gas of course costs very little, and can be easily obtained—it is used in every soda water fountain. The next morning, that of September fourth, the fruits may be marketed, and if the fruit dealers know human nature as well as they appear to, the fruit would be readily disposed of at a high price, if properly displayed and advertised. Recurring to the fruit of the date palm, the methods which have been elaborated in Arizona, when finally given finesse, will make it possible to utilize vast desert areas for the culture of the date palm, and so making an otherwise useless waste contribute to human welfare. Of the cultivated persimmon something the same may be said. In California the culture of this tree has fallen into desuetude, and in the southeast hundreds of acres of persimmons are practically of no profit, for the reason that a method of marketing edible fruit has been wanting until now. It remains only to perfect in detail for the several varieties of the fruit, the methods used by Gore[5] and as here outlined, when this desideratum will be compassed.

Having justified the scientific method from the practical point of view, as I believe to have been done, may I finally ask your attention to the further question which you will be sure to ask, namely, why carbon dioxide should act as it does. Why should a fruit which would remain under normal conditions inedible for its bitterness during a month or more, become quite edible in a week with a single dose of a certain gas, in 36 hours if the dose is doubled and in 15 hours if quadrupled? Let me prepare your minds for the answer by reminding you of the very familiar fact that it takes a good deal longer to cook an egg to hardness if a temperature considerably below boiling point is used than if it is subjected to 212 degrees or over. With this in mind, our attention may be directed to a few points concerning the structure of the fruits of which we have been speaking.

The edible flesh or pulp is composed of a great number of minute cellulose sacs (cells) each containing its quantum of living material as an inner lining, and this in turn filled with sap which is water with varying amounts of substances, such as mucilage, sugars, and salts, in solution. In both the persimmon and in the date, these sacs are of two quite distinct kinds, those from which tannin is absent, and which are relatively small; and those in which tannin occurs admixed with other substances in the sap. The tannin sacs are quite large, and may be readily distinguished by the unaided eye. You may see them in the ordinary dried dates of commerce as a layer of clear brown particles just beneath the somewhat tough skin. The color, however, is due to the oxidation of the tannin—in the fresh condition they are colorless, and can be recognized only by special means, that is, by applying suitable reagents which cause color changes in the tannin.

[5] Bulls. 141, 155, Bur. Chem., U. S. Dept. Agri.

If now we choose a persimmon which softens before it loses its astringency, it is possible to isolate from the pulp single tannin sacs, which may then be examined under the microscope. If uninjured—if the cellulose membrane is not ruptured—the watery contents will glisten with a satiny sheen. On adding water so that the tannin sac is surrounded by it, the sac absorbs water and bursts, and the contents ooze out. This simple fact of bursting in consequence of the absorption of water proves conclusively that there is something more than tannin present, as tannin in solution can not absorb water sufficiently to produce such an effect. Sugar or salts might, if in sufficient quantity; but we can prove in another way that the substance in question is of neither of these classes of material, for it is capable of coagulation, in much the fashion that, as every housewife knows, we may coagulate jelly by cooling it, or an egg by boiling it. In the case of our tannin sac material, we may use heat, or a variety of chemical substances. Of these I shall, for the present purpose, mention but one class, namely, the alkaloids, such as antipyrine, quinine, etc. If a solution of any of these be applied in the room of water, the jelly-like mass may swell somewhat at first, but soon becomes hard and rigid, giving off water and shrinking accordingly. At the same time, however, within the interior of the coagulated mass there appears a coarse white granulation, which is caused by the union of the alkaloid with tannin within the jelly. This relation of tannin to the jelly is brought out still more strikingly if we examine, in the same way, a tannin sac which has been taken from a fruit which has become nearly non-astringent. If we take a portion of the pulp into the mouth we do not at first notice the puckery effect. In a few moments, however, this develops and becomes more and more pronounced during several minutes. Under the microscope we can actually watch the process. On adding water to some suitably isolated tannin sacs, the contents swell more slowly than before, but ultimately burst out and form a bubble-like mass on the side of the sac. In a few moments a granular veil is seen developing just beyond the surface of the protrusion, gradually increasing in size and moving away further and further. It would take us too far afield to explain why this peculiar behavior, so it must suffice to say that it is due to escaping tannin, which leaves the mass out of which it has escaped unaffected in shape and size. The matter is quite analogous to the washing out of color from cloth: the color goes, the cloth remains. Repeating our experiment with antipyrine, we now find that, while coagulation takes place, the amount of shrinkage is less than before, and the action of the reagent on the tannin within the mass is less apparent for the reason that the granulations are smaller.

If finally we treat a tannin sac from a quite non-astringent fruit in the same way we shall find that it will swell but little or none at all in water, that the alkaloid causes little shrinkage if any, and that the tannin reaction does not take place at all. That the tannin is still there is, however, apparent if we use other reagents, all of which nevertheless act much more slowly than they are known to do when unripe material is tested by them. The conclusion therefore to which I arrive is that the reason we do not taste the tannin in the completely ripened fruit is not because it is not there, but because the jelly-like material which occurs in the tannin sacs along with the tannin itself becomes coagulated during the ripening process, so that the tannin may not escape from it except at a very slow rate—too slowly far to be detected even by the delicate membranes of the mouth. To recall what was said earlier in the hour, the tannin is protected by the jelly, so that the alkaloid can not act on it —and this the more efficiently as the coagulation is the more complete. Tannin itself, on the other hand, is not a coagulable material. Although a colloid, it does not have the physical properties of a jelly or mucilage. In a word, we have in the tannin masses of the ripe fruit a sort of vegetable leather, which, like ordinary leather, gives up its tannin only very slowly, as shown by long exposure to water. I have tannin sacs of the persimmon which have been lying in water for over two years, but, aside from the loss of tannin, they remain quite unchanged, and will doubtless do so for years to come.

But what of the relation of all this to the carbon dioxid? We can form some notion of the matter if we step aside to enquire somewhat into the behavior of this gas. The more ordinary name, carbonic acid gas, indicates that it is an acid, and it is therefore of a class of substances which may exert a coagulating (or flocculating) influence upon various colloids. For a single example, carbon dioxide has been found recently to cause the coagulation of the milk or latex of india-rubber trees. In coagulated latex, the india-rubber occurs as minute droplets which remain individual and separate until some coagulating agent has its way, when they run together to form a continuous mass of india-rubber. This is only one example of the effect of carbon dioxid upon substances in the colloidal state, and by it we are led to suspect that its rôle in the artificial ripening of dates and persimmons is referable to its coagulating power, a suspicion which is strengthened by the fact that the more there is available, as when it is supplied under pressure, the quicker is the effect. Some may look askance at so simple an explanation when so complicated a phenomenon is involved, and they are quite justified in doing so. This explanation is advanced not as final, but as a theory well worthy further examination by the experimental method, the method by which only can science be advanced, my purpose here being to discover a problem in science as it confronts the investigator rather than to lead you on the smooth, well-worn but less picturesque and romantic road in the domain of the already known. Let me, therefore, not tax your patience too far, enough, however, to allow me to reaffirm that the problems of science are not of mere academic interest; and that sooner or later they relate themselves to human life. The problem which has been outlined illustrates this principle, and it is one which I venture to assert is well worth the severe application of the investigator, entrenching as it does on that field of the physiology of the obscure processes of respiration, digestion, enzymatic action, the relations of crystalloids and colloids and the like—in short on that field where the physiology of living things, whether of animals or plants, overlaps the as yet undeveloped knowledge of collochemistry, a field surrounded by a wide horizon of the unknown, to pass which even with a stumbling tread requires a sure faith in the strength of the staff of scientific method.

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UNIVERSITY REGISTRATION STATISTICS

The registration returns for November 1, 1912, of twenty-nine of the leading universities of the country will be found tabulated on the following page. Specific attention should be called to the fact that these universities are neither the twenty-nine largest universities of the country in point of attendance nor necessarily the twenty-nine leading universities, nor is there any desire on the part of the compiler to insist upon a quantitative standard as the only proper basis for comparison of our institutions of higher learning. Five institutions exhibit a decrease in the total enrollment (including the summer session), namely, *Cornell, Illinois, Iowa, Johns Hopkins* and *Pennsylvania,* while four institutions showed a loss in the total enrollment last year, and three in 1910 and four in 1909. The largest gains in terms of student units, including the summer attendance, but making due allowance by deduction for the summer session students who returned for instruction in the fall, were registered by *Columbia* (1,069), *California* (733), *Minnesota* (515), *New York University* (488), *Texas* (475), *Nebraska* (391) and *Harvard* (303). Last year there were four institutions that showed a gain of over three hundred students, namely, *California, Columbia, Cornell* and *Ohio State,* whereas in 1911 and in 1910 there were seven institutions that registered such an increase. Omitting the summer session attendance, the largest gains have been made by *Indiana* (990), *Chicago* (700), *California* (690), *Columbia* (484), *New York University* (375), *Nebraska* (337), *Texas* (318), *Cornell* (284), *Northwestern* (232) and *Syracuse* (209). It will thus be seen that this year ten institutions exhibited an increase of over two hundred students in the fall attendance, as against four in 1911, seven in 1910 and eleven in 1909. It will be observed that of these institutions four are in the east, five in the west and one is in the south.

According to the figures for 1912, the

Faculties	California	Chicago	Columbia	Cornell	Harvard	Illinois	Indiana	Iowa	Johns Hopkins	Kansas	Michigan	Minnesota	Missouri	New York Univ.
College, Men	914	879	819	}1051	2306	454	1415	529	197	642	1550	633	774	413
College, Women	1425	720	590		483	348	925	494	....	540	732	908	480	182
Agriculture	429	....	....	1185	....	732	....	....	....	....	....	396	454	....
Architecture	116	....	129	133	†	341	....	....	....	....	†	†	....	....
Art	....	....	....	....	....	†	85	†	....	24	†	†	....	....
Commerce	297	....	....	....	107	206	....	†	....	....	†	....	....	1598
Dentistry	89	....	....	....	192	....	....	176	....	....	252	239	....	....
Divinity	....	132	....	....	48	....	....	....	....	....	....	....	....	....
Forestry	†	....	....	....	†	†	....	....	....	....	†	†	....	....
Graduate School (non-professional)	382	490	1399	296	532	256	151	131	207	84	206	63	112	315
Journalism	....	....	72	....	....	†	70	....	....	....	†	....	55	†
Law	159	177	457	294	740	122	105	218	....	184	654	237	121	693
Medicine	108	127	336	120	288	....	142	113	351	79	298	180	56	408
Music	†	....	20	....	....	79	118	....	....	118	†	†	....	....
Pedagogy	†	266	1606	....	....	†	540	†	....	208	†	82	181	355
Pharmacy	87	....	420	....	....	176	....	....	....	72	92	77	....	....
Scientific Schools*	735	....	634	1419	132	965	....	168	....	380	1284	591	344	190
Veterinary Medicine	†	....	....	120	....	....	....	....	....	....	....	....	....	16
Other courses	....	740	....	....	....	269	....	....	17	....	....	12	....	....
Deduct double registration	*156*	*165*	*334*	*13*	....	....	....	*63*	....	*219*	*145*	....	*189*	*107*
Total, November 1, 1912	4741	3366	6153	4605	4828	3948	2340	1766	772	2112	4923	3418	2388	4063
Summer Session, 1912	2275	3531	3602	1307	1046	640	1197	324	201	469	1324	494	691	645
Deduct double registration	*403*	*546*	*748*	*500*	*145*	*273*	*280*	*146*	*29*	*178*	*627*	*319*	*208*	*165*
Grand Total Nov. 1, 1912	6457	6351	9007	5412	5729	4315	2234	1944	1087	2403	5620	5063	2871	4543
Grand Total Nov. 1, 1911	5724	6062	7938	5609	5426	4929	2154	1967	1238	2265	5452	4548	2780	4055
Grand Total Nov. 1, 1910	4552	5883	5883	5169	5329	4659	2102	1957	890	2246	5339	4972	2678	3947
Grand Total Nov. 1, 1909	3968	5487	5487	5028	5558	4502	2221	2246	792	2144	5258	4351	2589	3843
Grand Total Nov. 1, 1908	3644	5114	5114	4700	5342	4400	2113	2356	707	2086	5188	4607	2558	3951
Grand Total Nov. 1, 1903	3477	4146	4146	3438	6013	3239	1086	1260	694	1319	3926	3550	1540	2177
Extension and similar courses	894†	3031	2959	....	..21	1000	114	207	114	367	....	1326	305	700
Officers	486	337	867	825	771	577	93	226	206	178	472	442	277	381

Faculties	Northwestern	Ohio State	Pennsylvania	Pittsburgh	Princeton	Stanford	Syracuse	Texas	Tulane	Virginia	Washington Univ.	Western Reserve	Wisconsin	Yale
College, Men	452	423	384	}400	1409	545	}1313	773	152	368	162	456	749	1326
College, Women	563	380	....		....	442		634	249	...	217	354	727	....
Agriculture	....	720	....	....	....	....	37	41	....	...	....	....	802	....
Architecture	....	41	215	....	....	....	55	55	15	...	44	....	....	}42
Art	....	....	....	....	....	....	175	....	68	...	....	....	....	
Commerce	450	....	636	....	....	....	....	....	....	...	....	....	317	....
Dentistry	478	....	508	176	....	....	....	....	52	...	101	127	....	....
Divinity	222	....	....	....	....	....	....	....	....	...	....	....	....	100
Forestry	....	74	....	....	....	....	177	....	....	...	....	....	....	40
Graduate School (non-professional)	80	107	403	40	148	94	75	55	17	40	53	14	268	429
Journalism	....	....	....	....	....	....	....	....	....	...	....	....	95	....
Law	368	194	385	143	....	136	240	318	87	226	76	130	160	132
Medicine	258	....	313	136	....	46	86	150	349	90	68	168	65	45
Music	452	....	30	....	....	....	855	....	91	...	....	....	60	92
Pedagogy	....	129	....	478	....	....	20	398	97	...	....	....	54	....
Pharmacy	193	85	....	195	....	....	....	61	12	...	....	111	15	....
Scientific Schools*	57	726	713	235	161	398	305	289	132	99	159	....	728	1139
Veterinary Medicine	....	155	115	....	....	....	....	....	....	...	....	....	....	....
Other courses	178	252	808	102	....	....	151	32	10	...	78	50	5	....
Deduct double registration	*132*	*12*	*220*	*72*	*150*	....	*97*	*553*	*93*	*24*	....	*32*	*88*	*80*
Total, November 1, 1912	3619	3274	4290	1833	1568	1661	3392	2253	1238	799	958	1378	3957	3265
Summer Session, 1912	78	600	751	....	....	50	257	927	1116	‡	....	....	1741	....
Deduct double registration	*65*	*266*	*198*	....	....	*41*	*120*	*164*	*105*	...	....	....	*557*	....
Grand Total Nov. 1, 1912	3632	3608	4843	1833	1568	1670	3529	3016	2249	799	958	1378	5141	3265
Grand Total Nov. 1, 1911	3438	3567	5220		1543	1648	3307	2539	2040	781	859	1331	5015	3224
Grand Total Nov. 1, 1910	3543	3181	5187		1451	1648	3248	2597	1985	688	796	1274	4745	3287
Grand Total Nov. 1, 1909	3197	3012	4857		1398	1620	3248		1882	767	811	1083	4245	3276
Grand Total Nov. 1, 1908	3113	2700	4555		1314	1541	3204		1171	757	806	1016	3876	3466
Grand Total Nov. 1, 1903	2740	1688	2644		1434	1370	2207		1037	613	761	765	3221	2990
Extension and similar courses	....	273	....	451	....	....	....	330	152	...	207	Inc.	10,644	....
Officers	437	274	549	271	223	278	265	226	313	100	184	212	595	431

* Includes schools of mines, engineering, chemistry, and related subjects.

† Included elsewhere.

‡ 1285 students in attendance on summer courses (see note in body of article).

twenty-nine institutions, inclusive of the summer session, rank as follows: *Columbia* (9,007), *California* (6,457), *Chicago* (6,351), *Harvard* (5,729), *Michigan* (5,620), *Cornell* (5,412), *Wisconsin* (5,141), *Minnesota* (5,063), *Pennsylvania* (4,843), *New York University* (4,543), *Illinois* (4,315), *Northwestern* (3,632), *Ohio State* (3,608), *Syracuse* (3,529), *Yale* (3,265), *Texas* (3,016), *Missouri* (2,871), *Nebraska* (2,811), *Kansas* (2,403), *Tulane* (2,249), *Indiana* (2,234), *Iowa* (1,944), *Pittsburgh* (1,833), *Stanford* (1,670), *Princeton* (1,568), *Western Reserve* (1,378), *Johns Hopkins* (1,087), *Washington University* (958), *Virginia* (799), whereas last year the order was *Columbia, California, Cornell, Michigan, Harvard, Chicago, Pennsylvania, Wisconsin, Illinois, Minnesota, New York, Ohio State, Northwestern, Syracuse, Yale, Nebraska, Missouri, Texas, Kansas, Indiana, Tulane, Iowa, Stanford, Princeton, Western Reserve, Johns Hopkins, Virginia.* If the summer session enrollment be omitted, the universities in the table rank in size as follows: *Columbia* (6,153), *Michigan* (4,923), *Harvard* (4,828), *California* (4,741), *Cornell* (4,605), *Pennsylvania* (4,290), *New York University* (4,063), *Wisconsin* (3,957), *Illinois* (3,948), *Northwestern* (3,619), *Minnesota* (3,418), *Syracuse* (3,392), *Chicago* (3,366), *Ohio State* (3,274), *Yale* (3,265), *Nebraska* (2,483), *Missouri* (2,388), *Indiana* (2,340), *Texas* (2,253), *Kansas* (2,112), *Pittsburgh* (1,833), *Iowa* (1,766), *Stanford* (1,661), *Princeton* (1,568), *Western Reserve* (1,378), *Tulane* (1,238), *Washington University* (958), *Virginia* (799), *Johns Hopkins* (772), whereas last year the order was *Columbia, Cornell, Michigan, Harvard, Pennsylvania, Illinois, Minnesota, California, Wisconsin, New York, Northwestern, Yale, Syracuse, Ohio State, Chicago, Nebraska, Missouri, Kansas, Tulane, Iowa, Stanford, Princeton, Indiana, Western Reserve, Tulane, Virginia, Johns Hopkins.*

Owing to the fact that no statistics were given last year for the individual faculties, it is impossible to compare the gains or losses, as was done for 1910 and previous years, but attention will be called to important changes in connection with the discussion of the individual institutions. So far as the individual faculties of the various universities are concerned, *Harvard* with 2,306 men and 483 women (Radcliffe College) leads in the number of college undergraduates, being followed by *Indiana,* with 1,415 men and 925 women; *California,* with 914 men and 1,425 women; *Michigan,* with 1,550 men and 732 women; *Chicago,* with 879 men and 720 women; *Nebraska* with 645 men and 897 women; *Minnesota,* with 633 men and 908 women; *Wisconsin,* with 749 men and 727 women; *Columbia,* with 819 men and 590 women; *Princeton,* with 1,409 men, and *Texas,* with 773 men and 634 women.

In agriculture *Cornell* leads with 1,185 students, being followed by *Wisconsin* with 802, *Illinois* with 732, and *Ohio State* with 720. In architecture *Illinois* with 341 is followed by *Pennsylvania* with 215, *Cornell* with 133 and *Columbia* with 129. *Syracuse,* with 175 art students, leads in that field; while *New York University* continues to lead in commerce with 1,598 students, being followed by *Pennsylvania* with 636, *Northwestern* with 450 and *Wisconsin* with 317. The largest dental school is at *Pennsylvania,* where 508 students are enrolled, as compared with 478 at *Northwestern,* 252 at *Michigan* and 239 at *Minnesota. Northwestern* has the largest divinity school, enrolling 222 students, as against 132 at *Chicago,* 100 at *Yale* and 48 at *Harvard;* these are the only universities in the list that maintain schools of theology.

Syracuse has 177 students of forestry, *Ohio State* 74, *Nebraska* 64 and *Yale* 40; at *California, Harvard, Illinois, Michigan* and *Minnesota* the forestry students are counted in with other departments. *Columbia* has a long lead in the number of non-professional graduate students, there being no less than 1,399 students enrolled in its faculties of political science, philosophy and pure science. *Columbia* is followed by *Harvard* with 532 students, *Chicago* with 490, *Yale* with 429 and *Pennsylvania* with 403. *Wisconsin* has the largest school of journalism, enrolling 95 students as compared with *Columbia's* 72, *Indiana's* 70 and *Missouri's* 55. The largest law school is at *Harvard University*, where 740 students are registered in this subject; *New York University* follows with 693 students, *Michigan* with 654 and *Columbia* with 457. In medicine *New York University* leads with 408, being followed by *Johns Hopkins* with 351, *Tulane* with 349, *Columbia* with 336 and *Pennsylvania* with 313. *Syracuse* has the largest number of music students, namely, 855, there being 452 at *Northwestern* and 118 at *Indiana* and at *Kansas*. The Teachers College of *Columbia University* is by far the largest school of education connected with any of the institutions in the list. It has an enrollment this fall of no less than 1,606 students, as against 540 students of education at *Indiana*, 478 at *Pittsburgh*, 398 at *Texas* and 355 at *New York University*. *Columbia* also has by far the largest school of pharmacy, enrolling 420 students, as against 195 at *Pittsburgh*, 193 at *Northwestern* and 176 at *Illinois*. As for the scientific schools, *Cornell* continues to maintain its lead in this branch, enrolling 1,419 students, as against *Michigan's* 1,284, *Yale's* 1,139, *Illinois's* 965, *California's* 735, *Wisconsin's* 728, *Ohio State's* 726, *Pennsylvania's* 713 and *Columbia's* 634. In veterinary medicine *Ohio State* leads with 155, being followed by *Cornell* with 120 and *Pennsylvania* with 115. All of the above figures for individual faculties are exclusive of the summer session attendance. The largest summer session in 1912 was at *Columbia University*, where 3,602 students were enrolled, as against 3,531 at *Chicago*, 2,275 at *California*, 1,741 at *Wisconsin*, 1,324 at *Michigan*, 1,307 at *Cornell*, 1,197 at *Indiana*, 1,116 at *Tulane* and 1,046 at *Harvard*.

The largest number of officers is found at *Columbia*, where the staff of teaching and administrative officers consists of 867 members, as against 825 at *Cornell*, 771 at *Harvard*, 595 at *Wisconsin*, 577 at *Illinois*, and 549 at *Pennsylvania*.

California.—The 894 students listed under extension and similar courses were divided as follows: San Francisco Institute of Art, 225; Wilmerding School of Industrial Arts, 190; University Farm School, 150; Short Course in Agriculture, 187; Correspondence Courses in Agriculture, 142. In addition there is an enrollment of approximately 37,000 students in the farmers' institutes, etc. Of the 159 law students, 62 are graduate students in the department of jurisprudence, candidates for the degree of J.D., and 97 are registered in the Hastings College of Law as candidates for the degree of LL.B. Of the medical students, 82 are enrolled in the first and second years at Berkeley, and 19 in the third and fourth years at San Francisco, and 17 in the third and fourth years at Los Angeles.

Columbia.—97 college students are also registered in the professional faculties of the university (in the exercise of a professional option) as follows: 45 seniors in law, 26 seniors and juniors in medicine, 9 seniors in mines, engineering and chemistry, 5 seniors and juniors in fine arts, 6 seniors and juniors in journalism, and 6 seniors in Teachers College. Of the students in education, 1,379 were enrolled in Teachers College and 227 in the school of practical arts.

Cornell.—No information was given as to the number of summer session students who returned for work in the fall, and an estimate was therefore made based on the returns in the previous year.

Harvard.—The 483 students mentioned under "College, Women" are registered at Radcliffe College, where 80 of the 532 graduate students are also to be found.

Illinois.—The decrease in the total registration this year is caused by the discontinuation of the work in medicine and dentistry on June 30, 1912. The 269 students listed under "other courses" consist of 33 students in the library school, and 236 women enrolled in the courses in household science. The latter students are registered in three colleges, namely, arts, science and agriculture, but are not included in separate figures for these schools.

Indiana.—The large increase is due to the establishment of courses in journalism, music and pedagogy, which were not represented in the table of 1910.

Iowa.—Of the 113 students in medicine, 14 are taking work in homeopathic medicine. The students listed under "extension and similar courses" are students in pharmacy, medicine, the nurses' training school of the college of medicine, and that of the college of homeopathic medicine, in which schools high school graduation is not required for admission. The falling off in the grand total is due to the fact that these students were included in the upper part of the table in previous years. Music is now a part of the new college of fine arts, for the regular courses in which high school graduation is required, but since music students are not required to submit any entrance credentials, it is difficult to tell how many of the fine arts students have met secondary requirements for a collegiate course.

Minnesota.—The decrease in numbers in the college of science, literature and the arts is undoubtedly due to the qualitative requirement for admission. The apparent decrease in law is explained by the change in classification. Under the new administration, the evening law school has been abolished, and that work is now offered through the extension division. The decrease in students electing art is due to the shifting of that department from the college of science, literature and the arts to the college of education. The registration of the graduate school will doubtless equal last year's figure before the close of the present year. The falling off in pedagogy is the result of a change in classification; a number, heretofore registered as specials in that college, are now regular students in the college of science, literature and the arts.

Missouri.—The decrease in the enrollment in the schools of law, journalism and engineering is due to the fact that the standards of admission of these schools have been increased by the requirement of two years of college work in addition to a four-years' high school course. This requirement was first imposed in the session of 1911–12, but in that session the second and third classes in the school of law, and the sophomore, junior and senior classes in the schools of engineering and journalism consisted of students who had entered under the old standards of admission. The elimination of one of these classes explains the decrease in enrollment in these schools during the past session. The decrease will probably be manifested during the next session in the school of law and during the next two sessions in the schools of engineering and journalism. The schools of education and medicine also require two years of college work for admission, but as this standard was established at an earlier date, all of the students who entered under the lower requirements have been eliminated and the enrollment in these schools is now beginning to increase.

New York University.—The school of commerce shows an increase of 226 over the total enrollment for last year. The requirements in this school are the same as they were last year and the increased attendance shows the demand for such courses. The medical college shows a decrease of 179 from the total enrollment of last year. The loss falls almost entirely upon the freshman class, which numbers 53 this year, as against 206 for November, 1911. The reason for this decrease in the entering class is that beginning with this year, one year of college work has been required for admission in addition to high school graduation. A one year preparatory course covering physics, chemistry, biology and scientific German is being offered for men who expect to enter the medical college next year, and there are at present 52 in this class whose names are included in the total for the collegiate division. The law school shows a small falling off of 16 from last year, which is doubtless due to the fact that in the autumn of 1911 the law school was placed on a strictly three-year basis for the degree.

Northwestern.—There is an increase in every school of the university excepting the medical school, but the most gratifying increase is in the college of liberal arts. A committee of alumni and officers started a campaign last year to interest the graduates in increasing the number of men. The campaign resulted in an increase in men in the freshman class over the previous class of fifty-two per cent.

Ohio State.—The total enrollment, including the summer session, shows but a slight increase, which is due to the fact that the summer school of 1912 showed a decrease of 166 in its enrollment. This was largely due to the fact that the appropriation for the summer school was cut by the legislature from ten thousand to five thousand dollars, and it was necessary that certain courses be eliminated. All secondary work was dropped, and all students were of college or graduate rank and were required to meet the entrance requirements of the college in which they wished to enroll.

Pennsylvania.—While the total enrollment has fallen off as compared with the figures of the preceding year, there is an increase of 82 in the number of first year men. The increase of 4 in the first-year enrollment of the medical school indicates that the heavy falling off in registration due to the gradual raising of entrance requirements since 1908 has been checked, and a healthy reaction should be noticed from now on. The apparent falling off in total enrollment in the veterinary medical school is partly explained by the fact that the graduating class last June, 58, was unusually large. The normal senior class is about forty. The decrease in enrollment in civil, mechanical and electrical engineering is not peculiar to the university this year, as it is reported that there has been a falling off in those courses generally throughout the country.

Princeton.—Of the 1,409 undergraduates, 150 are students in the undergraduate civil engineering department, while the 11 additional students listed under scientific courses are enrolled in the electrical engineering school.

Texas.—In the fall of 1908 the minimum number of entrance units on which a student might be admitted was increased from eight units to eleven units, and the following year from eleven units to twelve units, at which number it has continued until the present time. Beginning with the fall of 1909, five college courses were required for admission to the department of law, and since the fall of 1910, five courses have been required for admission to the department of medicine. The percentage of men over women registered in the college of arts this session is larger than ever before. This is doubtless explained by the fact that more men than heretofore are taking their pre-medical and pre-law training.

Tulane.—Fourteen of the students listed under medicine are enrolled in the post-graduate medical school. The 10 students listed under "other courses" are taking work in household economy. Inasmuch as no allowance was made in the table furnished for the summer session students who returned for work in the fall, an estimate was made based on the previous year.

Virginia.—1,285 of the students were in attendance on the summer school of 1912, which is not a part of the university session.

Washington University.—The 78 students listed under "other courses" are enrolled in the school of social economy. In addition to the students accounted for in the table, there are 140 registered in the school of fine arts, but these have been omitted because the school does not require a four-year high school course for admission. They have been included, however, under "extension and similar courses." Many of these students have a high school training and a number have even more. In two departments the university has steadily advanced the requirements, and the changes in these departments have lowered the registration and of course affected the attendance materially. In the law school the changes began in 1901–02. In this year a full four-year high school requirement for admission was enforced. In 1904–1905 the course was extended to a full three-year course, and the tuition was raised from eighty to one hundred dollars. In 1909–10 the department was removed from a location well down in the city to the new campus, and in 1910–11 a full year of college work was required for admission in addition to a four-year high school course. As a result of these changes, the registration has decreased from 124 in 1900–01 to 76 on November 1, 1912. The entering classes are showing a recovery from the increased requirement, and the total registration this year of entering students was 29 regulars and 9 unclassified, as against 17 regulars and 8 unclassified when the last change in the requirement of a full year of college work went into effect. More marked still has been the change in the medical school. Here a complete reorganization has been effected, vastly adding to the facilities and to the teaching staff, placing the instructors on a full time basis even in the clinical departments for the burden of the teaching and research, but retaining a considerable number of men on part time to supplement the work of the regular staff in instruction and in the clinics. In 1910–1911 the requirement for admission was advanced to a full year of college work in addition to a four-year high school course, the college requirement involving specific prescriptions in chemistry, biology, physics, German and English. The number received under this new requirement dropped to 13 from 50 the preceding year. Furthermore, the requirements for advanced standing were increased and rigidly enforced. The following year the entering class showed a recovery, the number rising to 23; but in 1912–13 (the current session), the requirement of two years of college work in addition to a full four-year high school requirement for admission, went into effect. This college requirement included specific prescriptions of two years of chemistry, one of biology, one of physics, two of German, one of English, and electives, and the requirements for admission to advanced standing were further advanced. Again, the tuition fee was raised to one hundred and fifty dollars from a fee ranging from one hundred to one hundred and forty dollars. This increased tuition fee affected all entering students either for the first year class or for advanced standing. Under this new requirement the registration for the entering class dropped to 5 and the number received to advanced standing dropped to 8, although 69 applied for advanced standing and a very great number for admission to the first-year class. As a result of the changes in the medical school, the registration dropped in three years from 185 to 68, and the number will probably decrease next year, as the last of the larger entering classes on the old basis will pass out. The registration of the college, where the admission requirements have remained the same, shows a fair increase.

Western Reserve.—In 1911–12 the law school became, as the medical school has been for some years past, a graduate school.

Wisconsin.—Of the 802 students in agriculture, 50 are graduate students, and of the 728 in the engineering school, 20 are graduate students. The figures for pharmacy are inclusive of 26 students enrolled in the two-year pharmacy course, which does not require four years of high school preparation. The 5 students listed under "other courses" are enrolled in the Wisconsin library school, and are also counted in letters and science. In addition there are 31 students enrolled in the library course, which does not require four years of high school preparation. The figures are also inclusive of the students enrolled in the short courses in agriculture and in dairying. Last year there were 424 in the former and 133 in the latter.

Yale.—The decrease in the enrollment in the law and medical departments is due to the continued application of the recently increased requirements for admittance to these departments. The present general requirement for admission to the Yale law school is a bachelor's degree from a college of approved standing. The general requirement for admission to the medical school is a college degree or evidence of completion of at least two years of regular college work. The registration in the first year classes of the law school and medical school is greater than the final registration in the first-year classes of these schools for last year.

Rudolf Tombo, Jr.

THE FUR SEAL CENSUS

Ever since the fur seal herd of the Pribilof Islands came into the possession of the United States, through the purchase of Alaska, in 1867, one of the most important practical problems in connection with its management has been the making of some sort of enumeration or estimate of its numbers. The first attempt was made in 1869 by Captain Charles Bryant, first agent in charge of the herd. He estimated that the animals occupied 18 miles of shoreline to an average depth of 15 rods, 20 seals to the square rod, giving a total of 3,265,000 breeding seals and young. He did not estimate the number of non-breeding seals, animals of three years or under of both sexes.

A second attempt was made in 1872–74 by Mr. Henry W. Elliott, a special agent of the Treasury Department. He followed the same method of gross estimate, refining somewhat upon Captain Bryant's work, as it were, reducing to feet and inches what his predecessor had expressed roughly in miles and rods. His breeding area differed radically from that of Captain Bryant—6,386,000 square feet instead of 23,500,000. He, however, assigned only 2 square feet to each individual animal, whereas Captain Bryant gave 14 square feet. These over- and underestimates practically balance each other and leave the results about the same. Mr. Elliot found a total of 3,193,000 breeding seals and young, 72,000 less than Captain Bryant. He estimated the non-breeding seals also, finding a number sufficient to bring the grand total for the herd up to 4,700,000 animals of all classes.

In 1890 Mr. Elliott duplicated his census of 1872–74. It was a greatly reduced herd he found at that date. The breeding area he estimated at 1,900,000 square feet, and applying to this the same space unit, found 950,000 breeding seals and young.

The next serious attempt to estimate the herd was made in 1895 by Mr. Frederick W. True, of the Smithsonian Institution, and Mr. Charles H. Townsend, then connected with the United States Bureau of Fisheries. The herd had suffered still further decline through the ravages of pelagic sealing, an indiscriminate form of hunting in the open sea particularly destructive to the breeding females. Messrs. True and Townsend were able to count the individual animals on certain breeding areas, 7,479 in all. From charts of the rookeries, on which the areas had been traced at the height of the season, the extent of the counted area was obtained and hence an individual unit of space. Each animal was found to occupy a space of 46 square feet on scattered breeding grounds and half this space on massed grounds. Completing the measure of breeding space for all the rookeries, from the charts, and applying to it the units of space, a total of 131,833 breeding seals and young was found, with non-breeding seals enough to bring the total for all classes up to 155,977.

Coincident with the above estimate was one made by Colonel Joseph Murray, a government agent on the islands. He estimated and counted the breeding families, 5,000, and assigned arbitrarily an average of 40 cows to each, thus reaching a total of 405,000 breeding seals and young.

In 1896 a new investigation of the fur seal herd was begun by a commission under the leadership of President Jordan, of Stanford University. Both the above estimates were before this commission. The method of obtaining the unit of space used by Messrs. True and Townsend commended itself as worthy of imitation, but on test the rookery charts were found unreliable and a new basis of estimate was sought. The areas on which individual cows had been counted in 1895 were recounted, and enough additional space to bring the total up to 16,679 individual cows, in 1,245 families, an average of 13 cows to a harem. A complete count of harems was then made with the intention of applying the average to it after the manner of Colonel Murray.

While this census of 1896 was in progress, however, it was discovered that there were more pups on the counted areas than the number of cows previously counted warranted, and a full count of pups showed them to outnumber the cows two to one. In all previous estimates it had been assumed that at the period of development in rookery population known as the height of the season all or practically all the cows were present. The count of pups proved this to be an erroneous assumption, that in fact when most of the cows were present half at least of them were at sea feeding. The average harem obtained from the count of cows was therefore abandoned and one obtained from the count of pups substituted. This gave a total of 157,405 cows, with a like number of pups, in 4,932 harems, or a total of 319,742 breeding seals and young. The estimate for non-breeding seals in 1896 brought the total for all classes up to 450,000 animals.

In 1909 the writer duplicated this census of 1896, finding 50,626 cows in 1,387 harems, or, adding a like number of pups, a total of 102,639 breeding seals and young, with non-breeding seals sufficient to bring the total for the herd up to 158,520 animals.

The method of enumeration thus established in 1896 has been continued each season since with slight variation. The method of estimate was not held to be exact. It was recognized that exact results could only be obtained by a full count of pups and this was considered in 1896 to be physically impossible. The chief importance of the enumeration, however, lay in its value as a measure of decline, and for this purpose the results were as satisfactory as a complete count would have been.

By the treaty of July 7, 1911, the United States secured, through the cooperation of Great Britain, Russia and Japan, the abolition of pelagic sealing. The herd was thus freed from the drain upon its breeding stock and hope for its restoration was revived. The season of 1912 was the first under the new treaty. It became important therefore to know the exact status of the herd and a full count of the pups was undertaken and successfully accomplished by the writer. The rookeries of St. Paul Island gave 70,035; those of St. George Island, 11,949—a total of 81,984 pups. As each pup accounts for a mother seal, there was a like number of breeding cows. The harems numbered 1,358, an average of 60 cows to each, giving a total of 165,325 breeding seals and young, with non-breeding seals estimated at 50,412, or 215,738 animals of all classes.

Omitting the non-breeding seals, which can only be estimated, and dealing only with the breeding seals, we find an excess of 62,685 animals over the estimate of 1909. Approximately 15,000 cows reached the rookeries in 1912 and brought forth their young, which under pelagic sealing would have been killed at sea. These with a like number of pups swelled the herd and account for 30,000 of the excess. The remaining 32,685, made up of cows and pups, are accounted for by underestimates in 1909, from applying to large rookeries averages obtained from smaller rookeries. The average harem for all the rookeries in 1912 is 60 cows; that used in making the census of 1909 was 36. If we deduct the 15,000 cows saved through cessation of pelagic sealing, the average harem for 1912 drops to 48. Applying the difference between this and 36 as a correction to the census of 1909 would add to it 16,644 cows and an equal number of pups, 33,288 in all, a figure sufficiently near to 32,685 to show that it is fairly accurate. As a matter of fact the herd has not changed much since 1909. The pelagic catch has merely taken, in the past three seasons, a number equal to the annual increment of gain, that is, the excess of young breeding cows over the natural loss in adults due to old age. By this normal increment of gain, which is about ten per cent. yearly, now protected from loss, will the herd rise to its former populous condition.

The counting of the fur seal herd is a simple but at the same time laborious process. The animals occupy six to eight miles of shore front, in a belt, varying in width with the character of the ground, but never more than 150 to 200 feet, often much less. The work must be done in the first week or ten days of August, between the close of the breeding season and the time when the pups become accustomed to the water. The adult animals are driven off by native helpers. The person counting and his assistant cut off a pod or group of pups, numbering 50 to 100, at a rookery end, forcing it along the beach for a distance of one or two hundred feet. The animals string out in a line, the older and stronger forging ahead, and the counting is done by twos and in groups of threes and fours while they are scattered. It is like counting sheep as they pass through a gate. A second pod is cut off and treated in the same way, and so throughout the length of the rookery. In the end the entire rookery population has merely been shifted along the beach a short distance, the adult animals return and conditions are soon readjusted. At certain places close search must be made for animals asleep or hiding in the crevices of the rocks. Through failure to get all of these at times the counts are slightly under the exact facts. Count must also be made of the dead, of which a number—1,060 for all the rookeries—were found, such deaths being incident to exigencies of rookery life. The counting of the 82,000 pups occupied eight days, the largest single day's work being 20,000.

The process sounds simpler than it really is. The adult animals are always more or less dangerous. The pups themselves have anything but gentle dispositions and their teeth are sharp enough to penetrate rubber boots.

The ground also presents difficulties. Long stretches of unstable bowlders are interspersed with jagged lava potholes. There are cinder slopes and basaltic benches. In places the rocks are worn smooth as glass by the friction of innumerable seal bodies and the bowlders near the water line are always treacherous with slime and slippery sea growths. Over all is the unspeakable Bering Sea weather—without sunshine and alternating between thick and thin fog accompanied by rain, flying spray and howling wind.

The result, however, repaid the effort. For the first time the breeding stock of the herd has been brought within the range of exact figures. The herd is shown to be in better condition than was expected. Its recuperation will be more rapid. The splendid body of pups disproves absolutely the contention which has recently played so important a part in discussions of the herd's condition, namely, that the stock of breeding males has been reduced too low or become invirile and impotent through the operations of land killing. The immediate response of the herd to its release from the drain of pelagic sealing as certainly proves this to have been its sole cause of decline.

George Archibald Clark
U. S. Bureau of Fisheries,
St. Paul Island, Alaska,
August 31, 1912

THE FUR SEAL MORTALITY OF THE PRIBILOF ROOKERIES IN THE ABSENCE OF PELAGIC SEALING[1]

The breeding season of 1912 for the Pribilof fur seal was the first in many years unaffected by pelagic sealing. The herd has promptly responded to the removal of this determining check to its increase. The deaths on the rookeries reflected not only the arrest of pelagic sealing but the drop in the rate of natural mortality which has been much more rapid than the rate of decrease of the herd. The question of mortality was investigated in 1896 and 1897 by the Fur Seal Commission, and during the past season by the writer, the death of the young being the chief concern in both cases. The loss during the entire season, until the migration of the cows and pups late in the fall, has never been covered, but the major portion occurs earlier and indicates the proportions of the mortality from natural causes. In 1896 and 1897, putting aside the heavy loss from pelagic sealing by using only the data prior to August 15, the approximate date on which starvation caused by the pelagic catch began to be fatal to the young on the rookeries, the two chief causes of mortality of pups were uncinariasis (hookworm disease) and natural starvation, the former leading and placing a heavy incubus on the herd. The seal mother bears a single pup each year, and will nurse no other than her own offspring. Pelagic sealing therefore caused the starvation of the young by an artificial interference with the herd, while natural starvation is due to accidental deaths of females which have nursing pups and probably also to their failure to find their offspring after returning from trips to sea. It was estimated at 30.8 per thousand in 1896. The total loss from all causes in 1896 before the middle of August was about 90 per thousand.

The data obtained in 1912 make necessary some readjustment. The total natural loss to August 22 on St. Paul Island is 880, or 12.5 per thousand. From starvation to the middle of August a death rate of 4.3 per thousand is indicated, and from uncinariasis for the whole season a rate of much below 1 per thousand. Uncinariasis has thus become a minor and insignificant cause of loss, ranking not higher than fourth, a result which must be due solely to the thinning out of the herd, for no artificial measures against *Uncinaria* have been applied. The worm could not be found on Polovina, Gorbatch and the Northeast Point rookeries, all formerly well infested. The old rookery strongholds for this disease in the sands of Zapadni, Reef and especially Tolstoi, are alone now occupied and they yielded only 17 uncinariated pups, 5 of which were associated with starvation, out of a total of 175 examined. By making these sandy

[1] Published by permission of the Commissioner of Fisheries.

areas rocky uncinariasis can probably be made and kept negligible.

Not so vulnerable are the rest of the natural losses and most of them are beyond the reach of any preventives man can apply. Starvation is perhaps still the most serious of these, but at least a close second are the constant and typical cases of asphyxia neonatorum, or suffocation of the new born, a hitherto unidentified fatality among the seals. This is an early loss, begins with the first births and of course ceases promptly with the last. Eighteen per cent. of the dead pups examined before the middle of August were thus asphyxiated, but as the autopsies did not begin (save for two cases) until July 23, when the height of the season was well passed, the indicated death rate of 2.3 per thousand is much too low. Pups dead of asphyxia neonatorum are promptly recognized by the presence of meconium and complete pulmonary atelectasis, or lungs without air. The meconium is made up of the products of metabolism of the fetus, accumulated in the large intestines during gestation, and is voided soon after birth. A few cases have only partial meconium and incomplete atelectasis. The immediate cause of the failure to establish breathing is inferred to be obstruction by the fetal membranes. Most pups are born more or less invested by parts of what was the bag of waters. The cow delivering her pup instantly proceeds to tear off the caul with her teeth, but she does not always succeed until after the pup is dead. The dead pups seldom show adhering membranes but one striking example, found on St. George Island by Mr. Clark, is significant. The caul was intact, fitted perfectly the whole head and effectually sealed the respiratory passages. Usually the little victims never get their first breath. Trampling or overlying at the critical moment probably prevents breathing in a few cases independently of the fetal membranes. There is no evidence that any of the pups examined was dead before birth.

In 1896 and 1897 this species of suffocation must have ranked third, or possibly second, in importance. Many of the earlier dead of those years, which were seen lying largely inaccessible in the heart of the harems and inferred to belong with the losses from *Uncinaria,* were probably suffocated at birth. It is characteristic of this loss that many of the dead are found in the original area of the harem as first formed, and all of them directly on breeding grounds. The pups die on the spot where born. Deaths from this cause will continue indefinitely, the defect in seal obstetrics being remediable by nature alone. But the loss may perhaps not increase much faster than *pari passu* with the growth of the herd, which is not the case with uncinariasis and apparently not with starvation and other losses. Roughly speaking there are now one third to one half as many breeding seals and young as in 1896; but the pup loss is one seventh and the adult loss one fifth that of 1896. As the various well-known losses have decreased in a much faster progression than the decrease of the herd, they may be expected to increase with its growth with corresponding rapidity, though the matter is to some extent influenced by such controllable factors as the proportion of bulls to cows.

The death of adult breeders is mainly from fighting, accidents of pregnancy and of other kinds. During the season of 1912 this loss was about 30 as against 159 in 1896.

An incidental discovery of less importance but of much interest, was made by Mr. Clark and the writer during the counting of the pups. It has been supposed that the ability to swim is not a birthright of the fur seal pup but an acquirement gained by diligent practise in August. The stampeding into the sea and ready swimming early in August of hundreds of pups which had never before been in the water, and corroborative observations, show that the pup can swim just as soon as it acquires sufficient strength and can manage its limbs.

M. C. Marsh
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MEMORIAL OF A CENTENARY

The interest of the annual meeting of the Academy of Natural Sciences of Philadelphia was enhanced by the presentation of an advance copy of the fifteenth volume of the quarto *Journal* of the society published in commemoration of the celebration last March of the one hundredth anniversary of its foundation. The volume consists of 753 pages illustrated by 59 plates, six of which are in colors. The work has been printed on specially prepared paper and is a noble specimen of typography. It is divided into two sections, the first consisting of the proceedings of the centenary meeting, an account of the banquet, a list of delegates, and a selection from the letters of praise and congratulation received from corresponding institutions at home and abroad, while the second part contains the following memoirs contributed by members and correspondents:

"Human Spermatogenesis, Spermatocytes and Spermiogenesis: A Study of Inheritance," by Thomas Harrison Montgomery, Jr.

"A Contribution to the Paleontology of Trinidad," by Carlotta J. Maury, with plates drawn by Gilbert Dennison Harris.

"Early Adaptation in Feeding Habits of the Starfishes," by John M. Clarke.

"Mimicry in Boreal American Lepidoptera," by Henry Skinner.

"The Petrographic Province of Neponset Valley, Massachusetts," by Florence Bascom.

"Description of a New Fossil Porpoise of the Genus *Delphinodon* from the Miocene Formation of Maryland," by Frederick W. True.

"A Synopsis of the Fishes of the Genus *Mastacembelus*," by George A. Boulenger.

"The Faunal Divisions of Eastern North America in Relation to Vegetation," by Spencer Trotter.

"The Relation of Smell, Taste and the Common Chemical Sense in Vertebrates," by George Howard Parker.

"On the Supposed Tertiary Antarctic Continent," by Sir William Turner Thistelton Dyer.

"Mollusk Fauna of Northwest America," by William Nealy Dall.

"The Relation of Plant Protoplasm to its Environment," by John Muirhead Macfarlane.

"Tetraplasy, the Law of the Four Inseparable Factors of Evolution," by Henry Fairfield Osborn.

"The Phylogenetic Value of Color Characters in Birds," by Witmer Stone.

"Further Experiments with Mutations in Eyecolor of *Drosophila:* the Loss of the Orange Factor," by Thomas Hunt Morgan.

"On the Radiation of Energy," by James Edmund Ives.

"The History and Zoological Position of the Albino Rat," by Henry Herbert Donaldson.

"The Gorgonians of the Brazilian Coast," by Addison E. Verrill.

"New Observations in Chemistry and Mineralogy," by George Augustus Koenig.

"A Study of the Variations and Zoogeography of *Lignus* in Florida," by Henry Augustus Pilsbry.

"Analyse der Süd-Amerikanischen Heliceen," by H. von Ihering.

"Experimental Studies in Nuclear and Cell Division in the Eggs of *Crepidula*," by Edwin G. Conklin.

A view of the academy's building serves as a frontispiece to the volume.

A copy of the academy's first publication in 1817, an unpretentious small octavo, was placed beside the sumptuous volume just issued. The earlier issue was printed on paper which has held its own through the wear and tear of more than four-score years and ten, although by no means specially manufactured for the purpose. A distinction was given to the volume by contributions from Ord, Say, Nuttall, Waterhouse, Maclure and Lesueur and by the really beautiful engravings of the last named naturalist, but the contrast of this first publication with the volume just completed is not so great as that of the academy of 1817, housed in three little rooms up Gilliam's Court with the society as now established and endowed.

The chairman of the library committee, Dr. Thomas H. Fenton, spoke at the last meeting of the academy of the commemorative volume as a fine specimen of book making and of the value of its contents as contributions to science, calling special attention to its promptness of issue, as distinguished from the delay usual in the appearance of such memorial publications. He offered the following which was unanimously adopted:

Resolved, That it is the sense of this meeting that the sincere thanks of the academy are due to the recording secretary, Dr. Edward J. Nolan, for his untiring zeal and industry in the preparation and editing of the splendid memorial volume presented to-night and for its extraordinarily prompt completion.

The entire edition will be ready for distribution before the end of the year.

SCIENTIFIC NOTES AND NEWS

A bronze bust of Dr. Eugene W. Hilgard, emeritus professor in the University of California, was recently unveiled in the foyer of the new agricultural hall at the same time that the building was dedicated. The occasion was also marked by the formal investiture of Professor Thomas F. Hunt as dean of the department of agriculture.

On Friday, the thirteenth of December, a complimentary dinner was given at the Cosmos Club to Dr. Theodore Nicholas Gill, of the Smithsonian Institution, in commemoration of the seventy-fifth year of his life and of the fifty-fifth year of his publishing activities as a naturalist. More than one hundred guests were in attendance, mainly scientific men. Admiral Stockton, U.S.N., president of the George Washington University, presided. Dr. L. O. Howard, permanent secretary of the American Association for the Advancement of Science, acted as toastmaster. The speakers were Dr. Herbert Putnam, librarian of Congress; Dr. C. E. Monroe, professor of chemistry in George Washington University; Dr. B. W. Evermann, of the U. S. Bureau of Fisheries; Dr. A. F. A. King; Dr. Hugh M. Smith, of the Bureau of Fisheries, and Dr. W. J. Holland, of the Pittsburgh Museum. Dr. Gill's remarks in reply were largely retrospective of his long residence in Washington and his connection with the Smithsonian Institution. Many letters were read from prominent naturalists and old friends of Dr. Gill. The dining room was festooned with fish-nets; aquaria were placed here and there upon the tables, and corals and sea forms of different kinds were intermingled with flowers as table decorations.

On the evening of December 13 a dinner was given in honor of Dean W. F. M. Goss by local members of the American Society of Mechanical Engineers, members of the faculty of the College of Engineering and members of the Council of Administration of the University of Illinois. The dinner was given in recognition of the election of Dean Goss to the presidency of the American Society of Mechanical Engineers.

Captain Roald Amundsen will be the guest of honor at the annual banquet of the National Geographic Society on January 11, in Washington. Rear Admiral Robert E. Peary will act as toastmaster. Captain Amundsen, a gold medalist of the National Geographic Society, for his voyage through the Northwest passage, is again gold medalist of the society for the discovery of the South Pole.

Among the prizes offered for competition by the Académie des Sciences the most important is the Bréant prize (100,000 francs, $20,000) for the cure of Asiatic cholera. From the income of the Bréant foundation the Paris Academy of Sciences has awarded prizes of $500 to Dr. Carlos J. Finlay and to Dr. A. Agramonte, of Havana for their work on the rôle of the mosquito in the propagation of yellow fever.

Oxford University has conferred the degree of doctor of science on Professor Ernest William Hobson, fellow of Christ's College, and Sadlerian professor of pure mathematics at Cambridge.

The Royal Geological Society of Cornwall has awarded its Bolitho gold medal to Mr. Geo. Barrow, for his services to Cornish geology.

Major E. H. Hills, F.R.S., has been appointed honorary director of the observatory, University of Durham.

Dr. Adeline Ames, Ph.D. (Cornell, '12), has been appointed assistant forest pathologist in the Bureau of Plant Industry, Washington, D. C.

Dr. James A. Honeij, Cambridge, has been appointed assistant physician at the Leper Colony, Penikese Island. He will have the use of the laboratory of the Harvard Medical School and will make a study of the fifteen cases of leprosy now on the island.

Professor George Grant MacCurdy, of Yale University, has been elected a corresponding member of the Société des Américanistes de Paris.

Professor John W. Harshberger, of the University of Pennsylvania, has been elected president of the Philadelphia Natural History Society, which meets at the Wagner Free Institute of Science. He has been made a member of the council of the Pennsylvania Forestry Association from Philadelphia County.

Mr. Frank M. Chapman, of the American Museum of Natural History, and Mr. Louis Agassiz Fuertes, of Ithaca, will leave New York in January to explore the Columbian Andes. They will make a survey of Colombia, beginning at the Magdalena River and working eastward to the Bogota plateau, then on up to the high mountains, reaching an altitude of 14,000 feet, and down into the Orinoco basin. The work will take about three months. Its purpose is primarily to obtain material for other "habitat groups" for the museum. Mr. Fuertes will sketch the birds, the flora and the landscape features of the country.

Dr. George E. Hale lectured at the Massachusetts Institute of Technology on December 17 on "The Magnetic Field of the Sun."

Dr. J. M. Coulter, of the University of Chicago, gave an address on "Problems in Plant Breeding," before the honorary fraternity, Delta Theta Sigma, at Ames, Iowa, on December 13. Professor N. E. Hansen, of Brookings, South Dakota, gave an address for the same society on "Siberia," on December 7, with special reference to the work of plant introduction work in the United States.

Two lectures on different phases of "Efficiency Engineering" have recently been delivered before the faculty and students of the College of Engineering of the University of Illinois. One lecture was by Mr. Harrington Emerson, of New York City; it emphasized the need of scientific study and adaptation of the human element in the industries. The second lecture was by Dean C. H. Benjamin, of the School of Engineering of Purdue University; it laid special stress on the necessary limitations of any efficiency system.

"The Rural Problem" was the subject of an address delivered before the students of the University of Wisconsin College of Agriculture last week by Dr. F. B. Mumford, dean of the University of Missouri College of Agriculture. This was the first of a series of similar lectures to be given during the winter.

By invitation of the University of Calcutta, Dr. A. R. Forsyth, F.R.S., will give a course of advanced lectures in pure mathematics early next year. His subject is "The Theory of Functions of Two or More Complex Variables."

The Dutch sculptor, Pier Pander (Rome), has executed a bronze medallion of van't Hoff. *Nature* states that any one desiring to purchase a copy of it should send a postcard to Professor Ernst Cohen, van't Hoff Laboratorium, University, Utrecht, Holland. The medallion will then be sent by the firm entrusted with the work. If 100 copies are sold the price will be 6.50 Marks. The price will be reduced to 5.50 Marks if 200 copies can be sold. The medallion has been executed after a portrait relief in marble by Pier Pander.

Dr. William James Vaughn, who has held the chair of mathematics since 1882 and the chair of astronomy since 1895 at Vanderbilt University, died on December 17, aged seventy-eight years.

Mr. Samuel Arthur Saunder, who while engaged as a schoolmaster, carried on important researches in astronomy, especially concerning the surface of the moon, died on December 8, aged about sixty years.

Mr. Peter Cameron, author of a work in four volumes, which appeared between the years 1882 and 1893, on "British Phytophagous Hymenoptera," died on December 1.

There will be no meeting of Section C (Chemistry), at the Cleveland meeting of the American Association for the Advancement of Science. The short time intervening between the decision of the American Chemical Society not to meet in affiliation with Section C this winter and the date of the meeting has made it impossible to prepare a suitable program. The meeting of Section C will, therefore, be postponed until the following year.

UNIVERSITY AND EDUCATIONAL NEWS

The University of Wisconsin plans to develop in due time a full course in medicine in accordance with the highest standards, and in so doing it will utilize the clinical facilities of Milwaukee as far as they are available according to the decision of the regents at their last meeting. At present only two years of the four-year medical course are given.

In connection with the announcement of the removal of Professor Herbert J. Webber from Cornell University to the University of California, the position which he will fill was incorrectly given. He will be director of the Citrus Experiment Station and dean of the Graduate School of Tropical Agriculture. The University of California has for several years maintained four separate substations in southern California. These are to be united into an enlarged research station which will probably be located at Riverside. While this station will be designated the Citrus Experiment Station after the dominant industry of southern California, the work will be with all crops which are grown in that region. The coupling with the station for agricultural research of the Graduate School of Tropical Agriculture will make it unique among our agricultural experiment stations.

At the State University of Kentucky Dr. Joseph H. Kastle has been appointed director of the Agricultural Experiment Station and dean of the College of Agriculture.

Dr. Jesse More Greenman has resigned from the University of Chicago and the Field Museum of Natural History to accept an associate professorship in botany at Washington University and the position of curator of the herbarium at the Missouri Botanical Garden. He will assume his duties in St. Louis on January 1.

Mr. C. R. Orton, of Purdue University, has been elected to fill the vacancy at the Pennsylvania State College, made by the resignation of Professor H. R. Fulton. Mr. Orton will take up his duties on January 1, and will have charge of the teaching and investigation in plant pathology which includes forest pathology as well as the other special courses in plant diseases.

DISCUSSION AND CORRESPONDENCE

PHILIPPINE SHARKS

To the Editor of Science: In the issue of Science for July 19, 1912, Mr. C. Tate Regan makes observations on some new Philippine sharks described by me and Mr. Lewis Radcliffe in two papers in *Proceedings of the U. S. National Museum* (Vol. 41, 1912). (1) Mr. Regan expresses the opinion that a shark characterized by a single dorsal fin, taken by the *Albatross* in the Sea of Mindanao at a depth of 585 fathoms and by us made the type of a new family and genus, is not what it seems to be; he "suspects" that the absence of the first dorsal is abnormal or accidental. This suspicion is not justified by any evidence afforded by the specimen itself, which has been critically examined by Dr. Theodore Gill and other competent zoologists, who were consulted in advance of publication. (2) Mr. Regan finds that *Nasiqualus,* established as a new genus of Squalidæ, "corresponds to a section of *Centrophorus* which has already received the names *Acanthidium* and *Deania.*" *Nasiqualus* certainly falls within the composite genus *Centrophorus* as conceived by Mr. Regan, but in either dentition or dermal structure it differs markedly from *Deania* and *Acanthidium.* The last named genus is not made a synonym of *Centrophorus* by Mr. Regan in his paper cited (*Annals and Magazine of Natural History,* Vol. II., eighth series, 1908) but of *Spinax* Cuvier, a name antedated by seven years by Rafinesque's *Etmopterus.* (3) Mr. Regan concedes that "a second new genus, *Squalidus,* is valid." Two esteemed correspondents, apparently having seen Mr. Regan's communication, have recently notified me that *Squalidus* is not a tenable name, being preoccupied. This name, however, does not appear anywhere in our paper. The name used was *Squaliolus,* in allusion to the small size of the type species, the fully mature male being only 15 cm. long.

H. M. Smith

Bureau of Fisheries,
Washington, D. C.

BERARDIUS BAIRDII IN JAPAN

During 1910 while in Japan studying and collecting whales for the American Museum of Natural History, I saw in the Imperial Museum at Tokyo the skeleton of a Ziphiioid whale belonging to the genus *Berardius*. Upon inquiry it was learned that the skeleton had been secured from a whaling company which conducted operations on the shores of Tokyo Bay.

As it was then too late in the season to permit of a personal visit to the whaling grounds, my friend Mr. M. Matsuzaki, of the Toyo Hogei Kabushiki Kaisha (Oriental Whaling Co., Ltd.) offered to secure a specimen for the museum. He was able to do so and in 1911 a very complete skeleton reached New York.

This specimen is referable without doubt to *Berardius bairdii* Stejneger, the type locality of which is Bering Island, Bering Sea.

According to Dr. F. W. True,[1] the collection of the National Museum contains three skulls and three skeletons of this rare species, all of which are from Alaska with the exception of one taken at Centerville, California. I do not know that this whale has been recorded in other localities; thus the skeleton in the Tokyo Museum with the one just received in New York extends to Japan the range of both the genus and species.

So far as I have been able to learn the "Tsuchi-kujira," as the Japanese call *Berardius bairdii,* is taken in summer and only in Tokyo Bay, not appearing at other points upon the coast. The other species of this interesting genus, *B. arnouxi* Duvernoy, has been recorded only in the seas about New Zealand.

Roy C. Andrews

American Museum of Natural History

ON CITING THE TYPES OF NEW GENERA

At the Boston Zoological Congress the following recommendation was adopted:

> To facilitate reference, it is recommended that when an older species is taken as the type of a new genus, its name should be actually combined with the new generic name, in addition to citing it with the old generic name.[1]

The point is, that a bibliographer should be able to cite the necessary new binomial for the typical species, from the place where the genus was originally defined. I have never heard any objection to the course suggested, but, presumably through inadvertence, the recommendation is not always followed. A noteworthy instance has just come to hand in Mr. Edmund Heller's interesting paper on new genera of African ungulates.[2] He does indeed print the combination *Dolichohippus grevyi,* but *Sigmoceros lichtensteini* (Peters), *Beatragus hunteri* (Sclater), *Oreodocas fulvorufulus* (Afzelius), *Ammelaphus imperbis* (Blyth) and *Nyala angasi* (Angas), types of their respective genera, are nowhere given their supposedly correct names.

T. D. A. Cockerell

IN THE INTERESTS OF BETTER SPEAKING

To the Editor of Science: Would it be at all worth while, now that the innumerable scientific papers of the midwinter are about to be read, to urge their readers to take a few elementary lessons in elocution before they ascend their platforms? It is difficult to compute to what extent esthetic pleasure, as well as facility of comprehension, would be added to if men of science understood better the art of putting their communications before the public. The main work of the professional elocutionist would be to show the prospective reader how to produce full, clear, rotund chest tones, instead of the thin, clouded, head tones which they too often adopt. If the dozen or so of precious hours that this would take is too much to demand, perhaps the following simple rules might be of some assistance; I am sorry that they are so very elementary, but in point of fact they are rules which are violated by fully one half of those who read:

1. Stand erect, with chest expanded and not contracted.

2. Consult a physician and see that the nasal bones do not obstruct the nasal passages.

[1] "An account of the Beaked Whales of the Family Zyphiidæ in the Collection of the U. S. National Museum," Bull. 73, 1910, pp. 60, 61.

[1] Science, October 18, 1907, p. 521.

[2] Smithsonian Misc. Coll., November 2, 1912, Vol. 60, No. 8.

3. If manuscript is to be read from, hold it in the hand (and hold it high); manuscript which is stationary on a desk causes a rigidity of the body which should be avoided.

4. The length of line of the type-written manuscript must be short—not more than seven inches. This is very important. The long line of the ordinary typed manuscript is convenient for the type-writer, but it is fatal to the reader. The effort necessary to catch the right line as the eye returns to the left-hand margin of the paper consumes energy which should be devoted to securing that mysterious *rapport* that must be established between reader and hearer if the function is not to be a painful one. For the same reason the type must be good and black, and the lines far apart. Whatever contributes to the physical ease of the speaker conduces also to that free and undistracted state of mind which is indispensable to the securing of the desired *rapport*.

5. Better still—make a mental note of the *Art und Weise* of those men of science (half our number perhaps) who, whether by instinct or by early training, know how to address an audience effectively. There is a subtle mental attitude about them, quite aside from physical details, which can perhaps be better caught by instinctive imitation than by conscious intention. May their tribe increase!

6. If, in addition, every individual reader would, in his own interest, see to it that there is enough oxygen in the audience-room to permit of ready comprehension on the part of his hearers, then indeed would the mid-winter scientific meeting become such a joy to the spirit as would brighten, in retrospect, many a coming month of solitary hard labor.

The essential matter of inspiring papers is always at hand; a little furbishing up of method of presentation is all that is needed to make that matter far more effective, in the way of presentation, than it is, too often, at present. Of this the reader may be certain—if he insists upon beginning his paper with his voice thin, low and veiled, and directed downwards upon the floor instead of outwards towards the level of his hearers' ears, the spirits of his auditors, so far as they have any esthetic quality at all, will also descend to their boots, and will remain there until another speaker gives them a chance at better nourishment.

X. Y. Z.

SCIENTIFIC BOOKS

Principles of Microbiology. By V. A. Moore. Ithaca, N. Y., Carpenter & Co. Cloth. Pp. xl + 506, 101 illustrations. $3.50.

It is unfortunate that the limited field which this book covers was not indicated in the main title. For as the subtitle tells us it is a "treatise on bacteria, fungi and protozoa pathogenic for domesticated animals." Even then it does not claim to be complete, but, as the author says, is a "text-book for veterinary students beginning the study of microbiology. It is not exhaustive but rather elementary in character."

The first 188 pages and the last 65 are given over entirely to the discussion of general bacteriological matters along the same lines that we find in any of the half dozen books on general bacteriology. As we look through the list of chapters we find the same familiar titles as in all the others: Historical Sketch, Bacteria and their Place in Nature, Morphology of Bacteria, Classification, Bacteriological Apparatus, Sterilization and Disinfection, Preparation of Culture Media, Isolation and Cultivation of Bacteria, Microscopic Examination, Vital Activities of Bacteria, Relation of Bacteria to Disease, Use of Animals, Bacteriology of Water and Milk, Immunity, Serum Diagnosis and Vaccine Therapy. The remaining 253 pages, or just half the book, treat of the application of these general principles to veterinary matters.

Although we recognize the fact that the book is intended only for beginners and does not pretend to be complete yet we feel that the half of the book dealing with general bacteriology might with advantage have been left out altogether. For this general part while admittedly incomplete does not in many instances give as good, nor as accurate and up to date discussion of the topics mentioned as do some of the general text-books. Neither is this part specific enough in its directions to serve the student as a laboratory guide. It would have been better to have referred the beginner to the standard text-books for the general discussion, or to have provided him with specific directions for undertaking laboratory work leading up to the applications of veterinary bacteriology. This would have allowed the author more space for the extension and elaboration of the more valuable and specific part of the book in a way which he is well qualified to undertake.

It is hardly necessary to specify the shortcomings of the general part more than to point out that the historical sketch contains no reference to the other and earlier workers than Leeuwenhoek; the chapter dealing with classification is inadequate and confusing, and includes practically none of the recent work; in describing the preparation of culture media the methods are old-fashioned and but scant notice is given to the present-day standard methods; under the description of cultures the standard card of the Society of American Bacteriologists is not mentioned, although it is included in the chapter on classification, where it does not belong.

The chapter dealing with the bacteriology of water and milk is entirely unsatisfactory. The Standard Methods of Water Analysis now in use in practically all laboratories in this country are neglected altogether, although they are mentioned as giving methods for the preparation of culture media. The methods of interpreting the results of an analysis are not at all clear nor do they accurately represent present-day practise.

The discussion of the relation of bacteria to milk, a subject which touches closely veterinary matters, is also given but brief consideration. Too great stress is laid on such matters as the bactericidal property of milk, a subject about which there is much question, and the topic of bacteria in milk, particularly the pathogenic bacteria, is treated altogether too briefly. The author might very well have expanded this discussion to considerable length in a book of this character.

The good points of the book, and they are many, are mainly to be found in the part dealing particularly with veterinary matters. Here we have a careful summary of our knowledge of veterinary microbiology. But even here clearness and accuracy seem many times to have been sacrificed to brevity, although on the whole this part of the book is deserving of much praise. In the treatment of many topics we might mention important points which have been omitted, as for instance, Winslow's classification of the *Streptococci*, the occurrence of *M. gonorrhœa* in animals, the recent separation of *Bacillus coli* into its varieties, the modern methods of staining *Treponema*. But while sins of omission are frequent, those of commission are relatively rare and unimportant. The illustrations are not abundant but are well chosen, though their quality is not up to the standard set by the rest of the typography.

F. P. Gorham

Brown University

Biology: An Introductory Study. By H. W. Conn. Boston, Silver, Burdett & Co. 1912. Price $1.50.

The opinion of the reviewer was once solicited by a representative of one of the large publishing houses of this country as to who could write a good elementary biology and the answer was given that Professor Conn could do this. I do not believe that the publication of his present book had any reference to my statement, but it has warranted this statement. The book presents the subject in the most satisfactory manner of any of the texts which have appeared. In the first place it is a dignified college biology, demanding the serious attention of the student. The treatment is logical, beginning with the simple and working towards the complex and decidedly at variance with the views of those who believe it pedagogical heresy to put a compound microscope in the hands of the beginner. The illustrations are inelaborate, but quite ample and very well selected. At the ends of the chapters are references to books and papers, mainly of historical interest and a group of suggestions is likewise given for laboratory work, but in no sense detailed laboratory directions; they concern hints for handling material which is not everywhere used for study. One of the most important things about the book is the etymological explanations of the meaning of technical terms, to be found throughout the text, while at the back is a well-selected glossary-index in one. There are some minor errors here and there, as the spelling of Robert Hooke's name as Robert Hooker, amyolitic for amylolytic, but these are few. The reviewer parts company with the author in regard to the prominence of amitosis in the light of the work of recent research in hydroid, cestode, pathologic and other departments; I do not believe that it is sufficiently emphasized that nutrition is the same in photosynthetic forms as in holozoic organisms, but that the difference is in the *obtaining* of nourishment, the one from inorganic substances, the other from foods ready formed. In the chapter "The Relations of the Chromatin to Heredity," the author thinks that it is "almost incredible that there can be in such a small compass the traits of characters which an individual transmits to its offspring." I think likewise and I do not believe that such is the case, but that the chromatin is a *determiner* of these traits, in the sense of Johanssen; unless this matter is presented to the beginning student in clear epigenetic terms, the whole matter will automatically reduce itself to a *reductio ad absurdum* in his mind.

The book is a strong argument for the biological Monroe Doctrine—biology for the biology classes. The discovery that animals and plants are built upon the same general plan and are in reality different aspects of the same thing is nearing a century in age, yet we teach the subject as if plants and animals were entirely disparate, and that there are no phenomena in common. The introductory course in physics and in chemistry aims to be general and to treat the science as a whole. It is as logical for the chemist to introduce his beginning students to organic chemistry, as for the biologist to make his elementary course mere botany or zoology. It is as futile to argue that no man can teach biology because he can not be a good botanist and a good zoologist at the same time as to assert that the teacher of physical chemistry can not be successful because he can not be both physicist and chemist: the point is that he is neither, he is a physical chemist, as the biologist should be a biologist. Professor Conn has given ammunition to the advocates of courses in general biology for beginning students.

M. M.

Handbook of Mental Examination Methods. By Shepherd Ivory Franz, Ph.D. New York, 1912. Nervous and Mental Disease Monograph Series No. 10.

Dr. Franz's volume adds another to the several recent handbooks of psychological methods and, as from a psychiatric angle, an addition quite worth making. It is an account of the simpler experimental methods to be used in the study of mental affections. The ground covered is the usual field of psychological experimentation, with a few special chapters, as one on Speech and Aphasia. The experimental methods described are taken somewhat from the literature, but are also largely the author's own, and in some of these latter instances it appears as though the field should have been more thoroughly gone over with reference to the work of others along similar lines. As to the single experiments described, the critic will appreciate that some experience with them is necessary to estimate their value for clinical purposes. Under Sensation are described the simple procedures with which most of us are familiar, though the methods of pain-measurement seem to be regarded as more objective than is the case. The reflexes and automatic acts are nearly passed over in the chapter on movement, though Franz has himself contributed to our knowledge of their pathology. Only the simpler methods are described for the observation of motor speed, accuracy, etc. The chapter on aphasia does not deal with experimental methods, but aims at sound guidance to clinical analysis. Much experimental material follows under the titles of attention, apprehension and perception, while the need for the special understanding of the immediate meaning of these words is recognized and met. Clinical methods have had a relatively large share in the development of experiment along these lines. As in other cases, the chapter on memory leaves the reader with a decided *sentimental d'incomplétude,* but the clinician should find very convenient the samples of material for the different sorts of memory tests. The work of Kent and Rosanoff has due recognition in the chapter on association, though not the work of the Zurich school, which is the opposite of the usual case. Some simple material which can be used for calculation tests is also presented. Under the "Time of Mental Processes" are discussed various forms of sorting tests, also of the *A*-test, these latter apparently all of Franz's own devising, though several other forms are extant. The remaining chapters are of an observational rather than experimental bearing, but are very useful in their present relation, especially the scheme of general examination, which is an excellent groundwork. In closing, there are described the elementary statistical procedures which the clinical observer might have occasion to use.

It is evident that to adequately write a book of this sort one must have the clinical viewpoint continually in mind and keep it continually in the reader's mind; the author has accomplished this better than other writers of similar books who have been physicians. The commentaries, both general and on the special tests presented, should be an exceedingly useful complement to the meager training in psychology which the younger physicians in our mental hospitals have usually received; it is for their hands that the book seems intended, and for whom it should perform its most useful work. The reference lists, however, are ill-proportioned and too condensed. The book is clear and very practical within certain limits, but it is not as good a book as its author should have written. F. L. W.

Building Stones and Clay-Products: A Handbook for Architects. By Heinrich Ries. New York, John Wiley & Sons; London, Chapman and Hall, Limited.

The work under the above title, comprising upwards of 400 pages, is acknowledgedly an attempt to prepare an elementary treatise on the subjects mentioned for the benefit of the students in the College of Architecture of Cornell University and for architects in general.

The first 250 pages of the work are devoted to building stones, the remainder to clay and clay-products. In attempting to cover so much ground within a limited number of pages much has to be omitted, and the question naturally arises if the subject does not suffer by such condensation to the extent of largely losing its value. The portion devoted to stone contains nothing that is not to be found in other easily available works and its usefulness must depend largely upon the method of arrangement of the subject material. The second portion is little more than an abbreviation of what the author has already included in his well-known work on "Clays, Their Occurrence, Properties and Uses." The subject is one on which the writer is acknowledgedly an authority.

The numerous illustrations are for the most part well selected and executed. A very good bibliography, glossary and index accompany the work.

A few minor errors are observed, as in the credit to Merrill on page 49, and to Watson on page 50. These are, however, comparatively immaterial matters.

Geo. P. Merrill

SPECIAL ARTICLES

THE RELATIONSHIPS OF THE CHESTNUT BLIGHT FUNGUS

The writer was the first to question the identity of the chestnut blight fungus, *Diaporthe parasitica* Murrill. In the 1908 Report of the Connecticut Agricultural Experiment Station he said:

We are not yet sure that *Diaporthe parasitica* has not been collected before under some other name. Professor Farlow calls our attention to the fact that "it comes more naturally under the genus *Endothia*, and is closely related to *E. gyrosa*." In de Thümen's "Myc. Uni.," No. 769, is a specimen under this name on *Castanea vesca* collected by Saccardo in Italy in 1876, whose Cytospora stage (the only stage showing in our specimen) seems quite like that of our chestnut fungus.

Ever since writing the above the writer has been endeavoring to gain additional evidence along this line. Since so-called *Endothia gyrosa* had been reported by Ellis and others on *Quercus* in this country, we made a special search on that host in Connecticut for this and similar fungi. It was not, however, until a field trip was made to Rock Creek Park, Washington, D. C., during the American Association for the Advancement of Science meeting of 1912, that we ran across the object of our search. Here we found, besides *Diaporthe parasitica* in its asco-stage on chestnut, a very similar fungus, also in the asco-stage, on two species of oak. A careful microscopic examination of the fungus on the oaks showed that it differed slightly from that on the chestnuts through its slightly narrower ascospores.

Shortly after making these collections we received from Saccardo specimens of *Endothia gyrosa* in their asco-stage on both chestnut and oak from Italy, and a careful microscopic examination of these showed that they were not only identical with each other, but also with those collected on oaks at Washington. This led me to say in a paper read shortly after at the conference called by the Pennsylvania Chestnut Blight Commission:

> The writer has since made a careful hunt for *Endothia gyrosa*, and has specimens of it on two species of oak collected in [Connecticut? and] the District of Columbia. Cultures have been made from these and from *Diaporthe parasitica* on chestnut obtained from the same localities. Our studies of these cultures and specimens from various localities are not yet complete, but they have gone far enough to say definitely that *Diaporthe parasitica* belongs in the same genus with the *Endothia gyrosa* on oak, and is at least very closely related to it, though at present my opinion is that they are distinct species.

And further on we said:

> Now, if *Endothia gyrosa* has a variety of hosts, including chestnuts, in Europe, and prefers a southern habitat, what of its preferences in this country? . . . *Endothia gyrosa* has been found on as many hosts in this country as in Europe, and likewise chiefly from the south. Why may we not expect to find it there on the chestnut?

In fact, we were then on our way south with this purpose in view, and we succeeded in finding at all the places which we visited *Endothia gyrosa* on both chestnut and oak that in its asco-stage or otherwise could not be distinguished microscopically from the fungus on the oaks at Washington and on the oak and chestnut sent by Saccardo from Italy. This led us to add, as a footnote to our Harrisburg paper, the following statement:

> After the Harrisburg conference, the writer went south especially to see if *Endothia gyrosa* or *Diaporthe parasitica* occurred there on chestnut, as suggested in this paper, though never having been so reported. Stops were made at Roanoke and Blacksburg, Va., Bristol, Va. and Tenn., at Ashville and Tryon, N. C., and at Lynchburg, Va., and at each place the suspected fungus was found on both chestnut and oak, and more frequently on the former. This fungus occurred as a languishing parasite or as a saprophyte, usually at the base or on the roots of the trees, and was never found forming isolated cankers on the otherwise sound sprouts, as is *Diaporthe parasitica* in the north. Apparently this fungus is the same on both the oak and chestnut, and the same thing as the so-called *Endothia gyrosa* on the same hosts in Europe. What its exact relationship is to *Diaporthe parasitica* has not yet been fully determined. In gross appearance its fruiting pustules are scarcely different, except possibly slightly less luxuriant as a rule. Its pycnidial spores, Cytospora stage, are apparently identical with those of *D. parasitica*, but the ascospores are evidently as a whole less luxuriant; that is, they are somewhat smaller, and especially slightly narrower. Whether these differences are those of a strain, variety, or distinct species, is yet to be determined by cultures, inoculations and further study.

At the request of the writer, Professor Farlow also wrote a paper (which was read by the writer) for the Chestnut Blight Conference, presenting his studies as to the identity of the chestnut-blight fungus. Farlow had a linear-spored *Endothia* on oak from America that he decided was related to but distinct from *Diaporthe parasitica,* and the European specimens of *Endothia gyrosa,* which latter, he stated, could not be distinguished morphologically from *D. parasitica.* It is quite evident, therefore, that Farlow was the first to call specific attention to the fact that in America there is a linear-spored *Endothia* on oak that is distinct both from *Diaporthe parasitica* of America and *Endothia gyrosa* of Europe; while the writer first called attention to the fact that there is a narrowly-oval spored form on both chestnut and oak in this country that is apparently distinct from *D. parasitica,* but identical with *Endothia gyrosa* on the same hosts in Europe.

Neither at this meeting, nor previously, had any other American botanist published on his own observations any statement of the relationship of *Diaporthe parasitica* to the genus *Endothia.* Rankin, however, in his paper presented at this conference, did say:

> The speaker has recently collected and examined a fungus indistinguishable from the chestnut canker disease on dead chestnut bark in several places in Virginia,

thus showing that he (and also Spaulding, as was learned later by discussion with him) had collected *Endothia gyrosa* without recognizing it. Some time before the Pennsylvania conference, however, von Höhnel, of Austria, and Saccardo, of Italy (in a letter to the writer), had compared specimens of *Diaporthe parasitica* from America with *Endothia gyrosa* from Europe, and, like Farlow, had come to the conclusion that morphologically they were identical. They knew nothing about the linear-spored *Endothia* and the real *Endothia gyrosa* in America.

Shortly after the conference a paper by Shear appeared in the April number of *Phytopathology,* in which he says:

> Our early unpublished studies of the chestnut bark fungus, made in 1907, convinced us that it was most closely related to the genus *Endothia,* as that genus is at present interpreted by mycologists. This opinion was also reached by Dr. Farlow, as reported by Clinton in 1908.

He also remarks further on:

> It is still uncertain whether *Diaporthe parasitica* is an indigenous American fungus or not. It is also a question whether the fungus reported as *Endothia gyrosa* and *E. radicalis* in Europe is the same as that to which the same names are at present applied in this country, and the exact relation of this European fungus to *Diaporthe parasitica* is also somewhat doubtful. The writer is investigating these questions and hopes to discuss them more fully later. One point at least we believe to be definitely determined, and that is the specific distinction between *Diaporthe parasitica* Murrill and *Endothia radicalis* (Schw.).

This last point had already been pointed out by Farlow in his paper, since he and Shear both had reference to the linear-spored form of *Endothia,* as shown by specimens since received by the writer from both.

In Science (May 10, 1912) Farlow republished his Harrisburg conference paper with some additions. In this paper Farlow speaks for the first time of the specimens collected by the writer. He says:

> As far as one can distinguish species by their morphological, apart from their pathogenic, characters, *Diaporthe parasitica* seems to me to resemble the Italian *Endothia radicalis* so closely that they can not be separated specifically unless it be by some peculiarity not hitherto recorded. There is still another point which should be considered. Is the fungus of our chestnut blight ever found on other trees? I have received a series of interesting specimens collected by Professor G. P. Clinton, which will illustrate this point. In some the bark of chestnuts and in others the bark of oaks is infested with an *Endothia* which in general appearance and in microscopic structure seem to me to be the same species.

Farlow further states that these specimens are distinct from the linear-spored form on oak.

Yet, in spite of all these statements, there have recently appeared in the October number of *Phytopathology* a second article by Shear and another by P. J. and H. W. Anderson—two papers which ignore, probably unintentionally, the published statements of Farlow and the writer, thereby giving their readers the impression that they are presenting certain facts for the first time. In his article Shear comes to the conclusion, after a trip to Europe, during which he collected specimens of *Endothia gyrosa* (*Endothia radicalis* of European authors, as he calls it) on chestnut, that this "is identical, morphologically, with *Diaporthe parasitica* Murrill, as found in America." This same conclusion, as we have shown, was previously made by von Höhnel, Farlow and Saccardo, but nevertheless is not quite correct, since our studies show that the ascospores of *Endothia gyrosa* from both Europe and America and on both oak and chestnut, are as a rule narrowly oval, while those of the true chestnut blight are broadly oval. However, since both forms have intergrading spores, the difference is very easily overlooked. Shear also apparently did not know that the real *Endothia gyrosa* of Europe also occurs as a native species in America, since he further states:

> As a result of our studies to date, we are of the opinion that *Diaporthe parasitica* Murrill is the same as *Endothia radicalis* of European authors, but not of Schweinitz, and that it was probably introduced into this country from Europe and has gradually spread from the original point of introduction, its spread being facilitated chiefly by borers or other animal agencies which produce wounds favorable for infection by the fungus.

The Andersons in their paper come to the conclusion that there are three species of *Endothia* in the United States, as follows:

> (1) *E. radicalis* (Schw.) Fr., (2) the true blight fungus—why not call it *Endothia parasitica?*—and (3) the Connellsville fungus, for which we propose the name *E. virginiana*, and for which we expect to write a description as soon as more of the European specimens have been examined.

It is too bad that they did not first carefully examine these European specimens, since their new species is the same thing as *Endothia gyrosa*. However, like the writer, they distinguished the difference between the ascospores of their so-called new species and those of the true chestnut blight. Also their culture and inoculation work agree in the main with the unpublished results of the writer. With their interpretation of Schweinitz's original description of *Sphæria gyrosa* as belonging to an entirely different fungus (a species of *Nectria*) we can not agree, as we believe Schweinitz originally had our fungus when he wrote his description in "Syn. Fung. Car.," No. 24.

The writer has received specimens from Farlow of his linear-spored *Endothia*, from Shear of this same fungus, which he calls "*Endothia radicalis* (Schw.)," and also of his recent collections of "*Endothia radicalis* of European authors" on chestnut from Italy, and from Detwiler of the Connellsville fungus (*E. virginiana* Anders.). We have had a chance to compare all of these under the microscope and most of them in cultures with the specimens we have collected and with the European specimens previously mentioned as received from Saccardo. We have also examined the Ellis and other specimens under *Endothia gyrosa* in the herbarium of the New York Botanical Garden and the Schweinitz specimens of *Sphæria gyrosa* and *S. radicalis* in the Philadelphia Academy of Science. We have made cultural experiments with *Diaporthe parasitica* extending over four years, and with *Endothia gyrosa* for nearly a year. We have made numerous inoculation tests with these two forms during the past summer. We also have cultures of the linear-spored *Endothia*. From this work and a careful review of all the literature bearing even remotely on the subject, we are positive that there are three forms of *Endothia* in America, all of which we believe to be native, and that at least one of them also occurs in Europe. We shall briefly discuss these as (1) the linear, (2) the narrowly-oval and (3) the broadly-oval spored forms of *Endothia*, as follows:

1. *The Linear-spored Endothia, E. radicalis* (Schw.) Farl.—The specimen from Florida issued by Ellis in "N. A. Fungi" No. 1956 as *Endothia gyrosa* (Schw.) is apparently this species, though the specimen in our set shows only a few ascospores and no asci. Likewise, the specimens issued by Ravenel as *Sphæria gyrosa* Schw. in his "Fungi Car" No. 49, on *Liquidambar* and *Quercus*, belong here, as

shown by the ascospores present in certain of the specimens the writer has examined. Ellis, in his description, "N. A. Pyren.," p. 552, however, really describes the next species better than this, since his measurements of the ascospores fit that species very closely. Ellis apparently merely copied Winter's measurements of the ascospores of *Endothia gyrosa* of Europe. His references to American specimens apparently all relate to the linear-spored form, and Anderson, who made Ellis's drawings, gives a fairly good illustration of this (a little too broad), probably made from the exsiccati specimen cited above.

Shear and Anderson refer this linear-spored species to *Sphæria radicalis* of Schweinitz, and we are inclined, after careful study of both the Schweinitz and the Fries descriptions, to believe that they may have had reference to this particular fungus. None of the original specimens, however, show ascospores, as far as known. Farlow, and not Fries, was the first to consider this form as coming under *Endothia,* and the first to definitely mention that the ascospores were linear, so we give him as the second authority for the name. Schweinitz also described the Cytospora stage of this same fungus, on wood of *Liquidambar* from Salem, as a new species, *Peziza cinnabarina,* No. 840 of his "N. A. Fungi," as shown by microscopic examination of this material. This would to-day come under Saccardo's genus *Endothiella* of the imperfect fungi.

The ascospores of the specimens we have studied vary from linear to linear-oblong, are occasionally slightly curved, are provided with an indistinct septum which probably is often absent, and are chiefly 6–10 μ (rarely 12 μ) long by 1–2 μ wide. The fruiting pustules of this species in its Cytospora stage are very similar to or identical with those of the other two forms. This species, however, is sharply differentiated through its ascospores from the other two, and to our mind represents the primitive species from which the next developed.

Perhaps most of the specimens called *Endothia gyrosa* in American herbaria come under this species, though it is impossible to say so definitely, since most of them are represented only by the Cytospora stage. So far as we have seen ascospore specimens, these have come from the south, so that they give it a present known distribution from Mississippi and Florida up to North Carolina. It is not known from Europe, apparently, but the assumption is not unreasonable that it might be found there, especially in the extreme southern part.

2. *The Narrowly-oval Spored Endothia, E. gyrosa* (Schw.) Fr.—The ascospores of this species vary from elliptical-oblong to narrowly oval, often tapering at one or both ends, have an evident septum, and are chiefly 6–9 μ long by 2–3.5 μ wide. Numerous comparative measurements of those taken from both oak and chestnut in Europe and America show no difference. When we compare the spores with those of the preceding species, however, the difference is quite evident to any one; when compared with those of the following form, the difference, while much less marked, is still sufficient for one with experience to distinguish the two by the slightly narrower spores of the species under consideration.

We believe that this is the fungus described by Schweinitz and by Fries as *Sphæria gyrosa,* and later made the basis of the genus *Endothia* by Fries. There is no doubt but that it is the European fungus called indifferently *Endothia gyrosa* or *E. radicalis,* which in its varied career has been placed under such other genera as *Valsa, Melogramma* and *Diatrype.* Streinz gives *Sphæria fluens* Sow. as a synonym, and Shear, after an examination of the specimen in the Kew Herbarium, thinks it the same, so far as can be told from the Cytospora stage. Other old-time names have been listed by botanists as synonyms, though probably not always correctly. Saccardo, having the Cytospora stage on wood instead of bark, created a new genus, *Endothiella,* with *E. gyrosa* as its type species. He knew its relationship to *Endothia gyrosa,* however. We are indebted to Saccardo for specimens of this type, and it is readily recognized as a stage similar to the small, simple, conical Cytospora fruiting pustules of *En-*

dothia gyrosa on wood in the southern part of this country. The true blight fungus also produces this modification on the wood of cut stumps in the north as does *E. radicalis* in the south. So far as the writer has seen, the asco-stage never develops later in these simple Cytospora fruiting pustules of *Endothiella.*

While some American botanists are ready enough to admit the identity of *Endothia gyrosa* of Europe, they question its relationship to *Sphæria gyrosa* of Schweinitz, upon whose specimens from North Carolina the species was originally founded. This doubt is brought about partly by the fact that, as in the case of *Sphæria radicalis* Schw., there are to-day no specimens of *Sphæria gyrosa* collected by Schweinitz that show the asco-stage, and this stage is necessary to properly identify any of these species. The writer thinks he has sufficient reasons, without the ascospores, to identify *Sphæria gyrosa* Schw. as the recognized *Endothia gyrosa* of Europe to-day. These are as follows:

1. While we have not looked for *Endothia gyrosa* at Salem, N. C. (the type locality of *Sphæria gyrosa*), we have no doubt that specimens of it can be found there to-day, since we collected it at points both north and south of that region.

2. Schweinitz gave the hosts as decaying bark of knots, also living bark of *Fagus* and *Juglans.* So far as the writer knows, neither *Endothia gyrosa* in Europe or this or a similar fungus in America has been found on either of these hosts. He has made a careful search on beech, butternut and walnut both north and south, during the past two years, without finding any suspicious fungus that he could connect with Schweinitz's *S. gyrosa.* Farlow has called attention to the question of error on the part of Schweinitz in determining hosts, as follows:

> Too much weight, however, should not be placed on the hosts given by Schweinitz, for an examination of fungi of different kinds collected by him shows that in his statements as to the hosts he was not always to be trusted.

This would be especially true of fungi collected on the exposed roots of trees, a common habitat of this fungus. Even if Schweinitz made no error in the determination of the hosts, we know that certain American botanists, as Marshall, about the time of Schweinitz's publication of his "Syn. Fung. Car." used the generic name *Fagus* to include the chestnut as well as the beech, and perhaps Schweinitz may have used it in this sense!

3. Both Schweinitz and Fries, to whom Schweinitz sent specimens, recognized *Sphæria gyrosa* and *S. radicalis* as distinct species, but with a very similar aspect. Both made descriptions of each of these species, and Fries placed them in separate sections of the genus *Sphæria.* Doubt as to identity would seem to be entirely removed by Fries's later note on *S. gyrosa,* in "Elench. Fung.," p. 84, where he states:

> With new examples sent by Schweinitz, others sent from western France by Guepin, and perhaps also those from Levieux, agree in every way. These tubercles break forth regularly from the bark of *Quercus racemosa,* but on barked wood the same thing is present simple in all respects, crowded, subconfluent, punctiform, without a distinct stroma. . . .

The latter is a very good description of the *Endothiella* stage already referred to.

4. The only specimen of *Sphæria gyrosa* in the mounted Schweinitz collection at the Philadelphia Academy of Science is No. 1431, which is evidently not the type, but a specimen received years after the original description, sent by Torrey from New England. This has already been shown by Farlow, Shear and the Andersons to be something else, a *Nectria,* and its identification as *Sphæria gyrosa* seems to be an error on Schweinitz's part, since he apparently had lost his type specimen when he received this. However, Farlow has a specimen in the Curtis Herbarium at Harvard, of which he writes me:

> The Schweinitzian specimen of *S. gyrosa* in Herb. Curtis at the present time shows no asci or spores, but there is a sketch with the specimen made by Curtis, from which it may be inferred that he saw spores, and that they were like those of *Diaporthe parasitica.*

Taking all the evidence into consideration, we can not see why the *Sphæria gyrosa* of America discussed by Schweinitz does not as certainly relate to the present *Endothia gyrosa* of Europe and America as does the *Sphæria gyrosa* of Europe discussed by Fries, on which no one raises a question. From Schweinitz's description of *S. gyrosa* and *S. radicalis* we believe he either had both of the species now recognized here, or else he had the Cytospora (*Endothiella*) and the mature stages of one, and described these as two species. In the latter case the evidence, as shown by the Curtis drawing, is more in favor of these descriptions applying to the narrowly-oval than to the linear-spored form. We think, however, that the simplest and best solution, until positive proof to the contrary is presented, is to decide that Schweinitz had both species. From their indistinguishable Cytospora stage, which was the stage usually found, it was natural enough that in time European botanists should place *S. radicalis* and *S. gyrosa* together in one species, especially if the former does not occur in Europe.

Having established the identity of our narrowly-oval spored form, what about its appearance in cultures and its action when inoculated into living hosts? Cultures from various localities in the south, from both chestnut and oak, have been under observation for over nine months, and all of these present identical characters that distinguish them rather easily from the true chestnut blight fungus when grown under the same conditions. We give these distinguishing characters briefly under our discussion of the latter fungus.

Inoculation tests were likewise made on seedling and sprout growths of both oak and chestnut, from cultures of *Endothia gyrosa* from both oak and chestnut, and these uniformly gave different results from the true blight fungus when inoculated under similar conditions. In other words, in no case did we succeed in producing very evident cankers from this fungus, and in most cases the inoculations were absolute failures. Yet there were indications of a semi-parasitic nature with a few inoculations made under conditions rather unfavorable to the host. The fungus is evidently largely a saprophyte, but with slight parasitic tendencies.

This fungus has so far been found on chestnut and oak in this country from North Carolina to southern Pennsylvania. It also occurs on these hosts in France, Italy, Switzerland and apparently in several other European countries. Saccardo gives other hosts and a wider distribution, but an examination of asco-material is necessary to verify these.

3. *The Broadly-oval Spored Endothia, E. gyrosa* var. *parasitica* (Murr.).—This is the true chestnut blight of the northeastern United States. Originally described as a new species, *Diaporthe parasitica*, by Murrill, it has since been called *Valsonectria parasitica* by Rehm and *Endothia parasitica* by the Andersons. Other botanists already mentioned do not distinguish it from the *Endothia gyrosa* just discussed. All botanists who have recently made a thorough study of it, however, seem to agree that it belongs more properly under the genus *Endothia*, as first suggested by Farlow and the writer, than under *Diaporthe*. From our own study we can not agree with those who think it identical morphologically with *Endothia gyrosa*, yet we believe it agrees with that species so closely that it belongs under it as a variety rather than ranks as a distinct species, as considered by the Andersons. Hence the name given in the heading.

The ascospores vary from narrowly- to broadly-oval, sometimes tapering somewhat to one or both ends, have a distinct septum at which they are sometimes slightly constricted, and are chiefly 6–10 μ long by 2.75–5 μ wide. Those of *S. gyrosa*, as given above, are 6–9 μ long by 2–3.5 μ wide, thus showing the chief difference to be in their width. Cultures of this fungus as compared with those of *Endothia gyrosa* grown on potato, lima bean and oat agars, give certain constant differences most strikingly shown perhaps when young on the potato and when old on the oat agar. These differences, briefly pointed out, are as follows:

1. The true blight fungus fruits earlier and more abundantly and discharges the spore drops more conspicuously than *Endothia gyrosa.*

2. It has more numerous, but less evident, smaller and more embedded fruiting bodies than the latter, where they are often elevated, distinct pustules, less covered by the exuding spore drops.

3. It develops a much less luxuriant aerial mycelium than the latter, except possibly in potato agar, where the growth in both at first is largely embedded, and much more highly colored with the former.

4. Its aerial mycelium, at first white, in old cultures is finally much less uniformly and highly orange colored than that of the latter, especially on oat agar, where the difference in the luxuriance and color of the two is usually striking.

Inoculations proving the parasitic nature of the chestnut blight fungus have been made previously by Murrill and others. Our inoculations were nearly all with pure cultures from various sources. We have produced cankers on seedling trees and chestnut sprouts, but more readily on the latter. We have produced cankers on chestnuts with cultures obtained originally from oak as well as from chestnut. We have also produced cankers, but much less readily and less conspicuously, on oak sprouts with cultures originally obtained from both oak and chestnut. We have had some differences in results of inoculations, which may be due either to the age of the cultures, season of inoculation, condition of host, original virulence of material used, or to these factors combined. Most of our inoculations with chestnut blight were made with proper checks and with similar inoculations with *Endothia gyrosa.* Our checks have all remained free, and the differences between the true blight inoculations and those of *E. gyrosa* have usually been marked.

The true chestnut blight has been found from New Hampshire to Virginia on several species of chestnut and oak, though rarely on the latter. This variety seems to be the most northern of the forms as indicated by present known distribution. It has not been recognized as yet outside of the United States.

We have gone into this subject minutely because a foreign origin of the chestnut blight fungus is of vital importance to those who advocate its control by cutting down infected trees and destroying their bark. Recently Smith, in October *Outing,* has gone to the extreme in advocacy of this quarantine method of control by outlining a plan for the expenditure of over four and a half million dollars. If, as advocated by the writer, the fungus is a native species, which, because of weather conditions unfavorable to its hosts, thereby weakening their vitality, has suddenly assumed an unusual and widespread prominence, it may in time go back to its previous inconspicuous parasitism. If, on the other hand, it can be proved to be an imported enemy, there is at least some basis for the fight for control, upon the whole impracticable, originally advocated by Metcalf and now so strongly pushed by those in charge of the work in Pennsylvania.

G. P. Clinton

Connecticut Agricultural
Experiment Station,
New Haven, Conn.,
November 22, 1912

THE CONVOCATION WEEK MEETING OF SCIENTIFIC SOCIETIES

The American Association for the Advancement of Science and the national scientific societies named below will meet at Cleveland, Ohio, during convocation week, beginning on December 30, 1912.

American Association for the Advancement of Science.—President, Professor Edward C. Pickering, Harvard College Observatory; retiring president, Professor Charles E. Bessey, University of Nebraska; permanent secretary, Dr. L. O. Howard, Smithsonian Institution, Washington, D. C.; general secretary, Professor H. E. Summers, State College, Ames, Ia.; secretary of the council, Professor H. W. Springsteen, Western Reserve University, Cleveland, Ohio.

Section A—Mathematics and Astronomy.—Vice-president, Professor E. B. Van Vleck, University of Wisconsin; secretary, Professor George A. Miller, University of Illinois, Urbana, Ill.

Section B—Physics.—Vice-president, Professor Arthur Gordon Webster, Clark University; secretary, Dr. W. J. Humphreys, Mount Weather, Va.

Section C—Chemistry.—Vice-president, Professor W. Lash Miller, University of Toronto; secretary, Professor C. H. Herty, University of North Carolina, Chapel Hill, N. C.

Section D—Mechanical Science and Engineering.—Vice-president, Dr. J. A. Holmes, U. S. Reclamation Service; secretary, G. W. Bissell, Michigan Agricultural College, East Lansing, Mich.

Section E—Geology and Geography.—Vice-president, Professor James E. Todd, University of Kansas; secretary, Professor George F. Kay, University of Iowa.

Section F—Zoology.—Vice-president, Professor William A. Locy, Northwestern University; secretary, Professor Maurice A. Bigelow, Teachers College, Columbia University, New York City.

Section G—Botany.—Vice-president, Professor D. S. Johnson, The Johns Hopkins University; secretary, Professor Henry C. Cowles, University of Chicago, Chicago, Ill.

Section H—Anthropology and Psychology.—Vice-president, Dr. J. Walter Fewkes, Bureau of American Ethnology; secretary, Professor George Grant MacCurdy, Yale University, New Haven, Conn.

Section I—Social and Economic Science.—Vice-president, John Hays Hammond, New York City; secretary, Seymour C. Loomis, 69 Church St., New Haven, Conn.

Section K—Physiology and Experimental Medicine.—Vice-president, Professor J. J. McCleod, Western Reserve University; secretary, Professor George T. Kemp, 8 West 25th St., Baltimore, Md.

Section L—Education.—Vice-president, Professor J. McKeen Cattell, Columbia University; secretary, Professor C. Riborg Mann, University of Chicago, Chicago, Ill.

The Astronomical and Astrophysical Society of America.—December 30–January 4. President, Professor E. C. Pickering, Harvard College Observatory; secretary, Professor Philip Fox, Dearborn Observatory, Evanston, Ill.

The American Mathematical Society.—December 31–January 2. President, Professor H. B. Fine, Princeton University; secretary, Professor F. N. Cole, 501 West 116th Street, New York City.

The American Federation of Teachers of the Mathematical and the Natural Sciences.—Between December 30–January 4. President, Professor C. R. Mann, University of Chicago; secretary, Eugene Randolph Smith, The Park School, Baltimore, Md.

The American Physical Society.—President, Professor W. F. Magie, Princeton University; secretary, Professor Ernest Merritt, Cornell University, Ithaca, N. Y.

The American Society of Biological Chemists.—December 30–January 1. President, Professor A. B. Macallum, University of Toronto; secretary, Professor A. N. Richards, University of Pennsylvania, Philadelphia, Pa.

The American Physiological Society.—December 30–January 1. President, Dr. S. J. Meltzer, Rockefeller Institute for Medical Research, New York City; secretary, Professor A. J. Carlson, University of Chicago, Chicago, Ill.

The Society for Pharmacology and Experimental Therapeutics.—December 30–31. President, Professor John J. Abel, The Johns Hopkins University; secretary, Dr. John Auer, Rockefeller Institute for Medical Research, New York City.

The American Society of Naturalists.—January 2. President, Professor E. G. Conklin, Princeton University; secretary, Professor A. L. Treadwell, Vassar College, Poughkeepsie, N. Y.

The American Society of Zoologists.—December 30–January 1. *Eastern Branch:* President, Dr. A. G. Meyer, Tortugas, Fla.; secretary, Professor J. H. Gerould, Dartmouth College. *Central Branch* (in charge of meeting): president, Professor H. B. Ward, University of Nebraska; secretary, Professor W. C. Curtis, University of Missouri, Columbia, Mo.

The Association of American Anatomists.—December 31–January 2. President, Professor Ross G. Harrison, Yale University; secretary, Professor G. Carl Huber, 1330 Hill Street, Ann Arbor, Mich.

The Entomological Society of America.—December 31–January 1. President, Professor Stephen A. Forbes, University of Illinois; secretary, Professor Alexander D. MacGillivray, 603 West Michigan Ave., Urbana, Ill.

The American Association of Economic Entomologists.—January 1–3. President, W. D. Hunter, Dallas, Tex.; secretary, A. F. Burgess, Melrose Highlands, Mass.

The American Microscopical Society.—December 31–January 1. President, Dr. F. D. Heald, Philadelphia; secretary, T. W. Galloway, Millikin University, Decatur, Ill.

The Botanical Society of America.—December 31–January 3. President, Professor L. R. Jones, University of Wisconsin; secretary, Dr. George T. Moore, Botanical Garden, St. Louis, Mo.

Botanists of the Central States.—Between December 30 and January 4. President, Professor T. H. Macbride, University of Iowa; secretary, Professor Henry C. Cowles, University of Chicago, Chicago, Ill.

The American Phytopathological Society.—December 31–January 3. President, Dr. G. P. Clinton, New Haven Agricultural Experiment Station; secretary, Dr. C. L. Shear, Department of Agriculture, Washington, D. C.

The American Nature-Study Society.—December 30–31. President, Professor Benjamin M. Davis, Miami University; secretary, Dr. Elliot R. Downing, University of Chicago, Chicago, Ill.

The Association of Official Seed Analysts.—January 2. President, Dr. E. H. Jenkins, New Haven, Conn.; secretary, E. Brown, U. S. Department of Agriculture, Washington, D. C.

The Society for Horticultural Science.—December 31. President, W. T. Macoun, Ottawa, Canada; secretary, C. P. Close, U. S. Department of Agriculture, Washington, D. C.

American Association of Official Horticultural Inspectors.—January 2–3. President, Dr. T. J. Headley, New Brunswick, N. J.; secretary, T. B. Symons, College Park, Md.

The American Anthropological Association.—December 30–January 3. President, Dr. J. Walter Fewkes, Bureau of Ethnology; secretary, Professor George Grant MacCurdy, Yale University, New Haven, Conn.

The American Folk-Lore Society.—January 1. President, John A. Lomax, University of Texas; secretary, Dr. Charles Peabody, Peabody Museum, Cambridge, Mass.

The American Psychological Association.—December 30–January 1. President, Professor Edward L. Thorndike, Columbia University; secretary, W. Van Dyke Bingham, Dartmouth College, Hanover, N. H.

The Sigma Xi Convention.—January 2. President, Professor Henry T. Eddy, University of Minnesota; secretary, Dr. Dayton C. Miller, Case School of Applied Science, Cleveland, Ohio.

Gamma Alpha Graduate Scientific Fraternity.—December 31. President, Professor William Crocker, University of Chicago; secretary, Professor H. E. Howe, Randolph-Macon College, Ashland, Va.

NEW HAVEN

The Geological Society of America.—December 28–31. President, Professor H. L. Fairchild, Rochester University; secretary, Dr. Edmund Otis Hovey, American Museum of Natural History, New York City.

The Association of American Geographers.—December 27–30. President, Professor Rollin D. Salisbury, University of Chicago; secretary, Professor Albert Perry Brigham, Hamilton, N. Y.

The Paleontological Society.—December 30–31. President, David White, U. S. Geological Survey; secretary, Dr. R. S. Bassler, U. S. National Museum, Washington, D. C.

BOSTON

The American Economic Association.—December 27–31. President, Professor Frank A. Fetter, Princeton University; secretary, Professor T. N. Carver, Harvard University, Cambridge, Mass.

The American Statistical Association.—December 27–30. President, Professor Walter F. Willcox, Cornell University; secretary, Carroll W. Doten, 491 Boylston Street, Boston, Mass.

The American Sociological Society.—December 27–31. President, Professor Albion W. Small, University of Chicago; secretary, Scott E. W. Bedford, University of Chicago, Chicago, Ill.

The American Association for Labor Legislation.—December 27–28. President, Professor Henry R. Seager, Columbia University; secretary, Dr. John B. Andrews, 131 East 23d St., New York City.

The American Home Economics Association.—December 30–31. President, Miss Isabel Bevier, University of Illinois; secretary, Benjamin R. Andrews, Teachers College, Columbia University, New York City.

NEW YORK CITY

The Society of American Bacteriologists.—December 31–January 2. President, Dr. Wm. H. Park, New York City; secretary, Charles E. Marshall, Amherst, Mass.

The American Philosophical Association.—December 26–28. President, Professor Frank Thilly, Cornell University; secretary, Professor Edward G. Spaulding, Princeton University, Princeton, N. J.