# NATURE

No. 3920 SATURDAY, DECEMBER 16, 1944 Vol. 154


## CONTENTS


| | Page |
|---|---|
| Function of Controls in Industry | 745 |
| Birds and the Camera. By Miss Frances Pitt | 748 |
| The Charm of Flowers. By Major T. H. Hawkins | 749 |
| Food Science. By Dr. T. Moran | 749 |
| The Advance of Biochemistry. By Dr. E. F. Armstrong, F.R.S. | 750 |
| Physics and Philosophy | 751 |
| Mountains that have Travelled Over Volcanoes. By Dr. E. B. Bailey, F.R.S. | 752 |
| Scientific Collaboration between India and Britain | 756 |
| Obituary: Sir Arthur Eddington, O.M., F.R.S. By Sir H. Spencer Jones, F.R.S.; Prof. E. A. Milne, F.R.S.; Prof. E. N. da C. Andrade, F.R.S. | 757 |
| News and Views | 761 |
| Letters to the Editors: Unification of the Theories of Photon and Meson.—Prof. Max Born, F.R.S. | 764 |
| Excretion of Penicillin in Man.—J. H. Humphrey | 765 |
| Ammonia Excretion and the Clearance of Mepacrine.—Lieut.-Colonel B. G. Maegraith, Major G. M. Brown, Major R. J. Rossiter, Capt. K. N. Irvine, Capt. J. C. Lees, Capt. D. S. Parsons, Capt. C. N. Partington, Capt. J. L. Rennie and Surg.-Lieut. R. E. Havard | 766 |
| Viscero-Motor Reflexes.—Prof. B. A. McSwiney, F.R.S., and C. B. B. Downman | 766 |
| Role of Acetylcholine and Vitamin $B_1$ in Nervous Excitation.—Prof. A. v. Muralt | 767 |
| Metabolism of Symmetrical Trinitrotoluene.—R. Lemberg and J. P. Callaghan | 768 |
| Specific Protective Influence of Alanine in Differential Tissue Destruction by Hexenolactone (Parasorbic Acid).—Theodore S. Hauschka | 769 |
| Absolute Photopic Sensitivity of the Eye in the Ultra-violet and in the Visible Spectrum.—N. I. Pinegin | 770 |
| New Light on the Mammalian Ear Ossicles.—Dr. T. S. Westoll | 770 |
| Control of Buried Viable Weed Seeds by Means of Boron.—Watkin Williams | 771 |
| Mechanism of the Milling Shrinkage of Wool Fabrics.—Dr. C. S. Whewell, L. Rigelhaupt and A. Selim | 772 |
| Halogenation in the Allyl Position.—Dr. W. A. Waters | 772 |
| A Colour Reaction for Aromatic Amidines.—Dr. A. T. Fuller | 773 |
| David Forbes and Guano Archæology.—George A. Kubler and G. E. Hutchinson | 773 |
| Medical Studies in Britain. By Dr. G. Lapage | 774 |
| Deciduous Cypress (*Taxodium distichum*). By Alexander L. Howard | 775 |
| North American Archæology and Cultures. By G. H. S. Bushnell | 776 |



*Editorial and Publishing Offices*
MACMILLAN & CO., LTD.,
ST. MARTIN'S STREET, LONDON, W.C.2.
Telephone Number: Whitehall 8831
Telegrams: Phusis Lesquare London





The annual subscription rate is £4 10 0, payable in advance, Inland or Abroad.




## FUNCTION OF CONTROLS IN INDUSTRY

THE eighth report of the Select Committee on National Expenditure for the session 1943–44 arose out of an inquiry into the chemical controls of the Ministry of Supply, and should remove certain widespread misapprehensions by making plain their functions and responsibilities. Although primarily concerned with the chemical controls, since these are only a part of the organization of the Ministry of Supply for dealing with the chemical industry, the inquiry could not be confined strictly to the activities for which the controllers and their staffs are responsible. In addition to the evidence of the controllers themselves and of the chairman of the Chemical Control Board, evidence was heard from the Ministry of Supply, including the Raw Materials Department and the Director-General of Scientific Research and Development, and the Ministry of Aircraft Production, including the Director-General of Materials Production and the Deputy Director of Research and Development (Technical Investigations). Memoranda were also submitted by trade associations and their firms. The report is accordingly a useful contribution to the present debate on the organization and control of post-war industry.

There are five chemical 'controls', dealing respectively with sulphuric acid, fertilizers, industrial ammonia, molasses and industrial alcohol, and plastics; the control of miscellaneous chemicals has recently been taken over by the headquarters of the Raw Materials Department of the Ministry of Supply. The controls thus form a group within the twenty-nine raw material controls administered by the Ministry, the five controllers constituting a board presided over by a chairman who is responsible for co-ordinating their activities. Describing first the responsibilities and functions of the controls, the report points out that in principle they are executive. The ultimate responsibility for the supply of essential raw materials lies with the Raw Materials Department of the Ministry of Supply; but the controls are the source of information and advice about the complex industries with which that Department has to deal. They thus perform an important advisory function in what may be called the semi-technical field of trade and industry. They are concerned with every kind of action which the Department may be required to take to ensure supplies and their proper distribution and use. In addition to a general supervision of the trade or industry with which it deals, a control may initiate arrangements for the import of supplies from abroad, the provision of new capacity in Great Britain, the distribution of material to the manufacturers or users, and the rationing of supplies to manufacturers and users; and it directs the purposes for which materials may be used and fixes the price of materials.

The importance of utilizing, in the administration of the controls, the knowledge and experience of the trades and industries concerned, has led to the appointment of staff mainly formerly employed in

the relevant businesses, and the report details the over-riding principles which have been laid down to safeguard the public interest in making such appointments. There is no suggestion in the report that these safeguards have not proved adequate; but the report emphasizes that the advisory and information services should be a two-way function; in particular, in referring to the use of existing capacity, the Committee points to the need for giving more adequate explanation to manufacturers whose capacity cannot, for one reason or another, be fully employed. This is a particular illustration of the importance of the advisory committees of manufacturers and others which in some sections of the chemical industry, notably in the fertilizer industry, assist the control to settle both the programme and the way to execute it. So long as the controls remain it is of the utmost importance that they should retain the confidence of the industry, and the existence of an active advisory committee is an excellent means to that end. None the less, in view of the easing of the supply position and the decrease in work, the Committee recommends that the whole organization of the chemical controls should be reviewed and consideration given to the advantages of absorbing them into the headquarters of the Raw Materials Department.

While much of the criticism of the controls is attributed to ignorance of their true position, specific allegations regarding their operation relate to the use of existing capacity, the distribution of new capacity to firms, the allocation of contracts for research and development, and the concentration of production in the paint industry. With regard to the first, the Committee considers that furnishing more adequate explanations and using advisory committees, as already indicated, would have removed its substance. In regard to the second and third points, and particularly the development of methyl methacrylate sheeting or 'Perspex', the Select Committee queries the mode of following the usual policy and giving the whole of the additional capacity for making 'Perspex' to the one original manufacturer. The report suggests that progress might have been more rapid if other firms with the necessary technical facilities had been brought in. A fresh approach to the problems might have resulted in greater progress towards a satisfactory solution.

On the whole, the operation of the chemical controls has tended to strengthen rather than diminish the preponderance of the strongest interests in the chemical industry. This tendency, the Committee recognizes, may be to some extent inevitable in time of war, but in spite of the immense value to the national effort of the resources of the interests in question, there is danger that too much reliance may be placed on the strength of a single concern, making, for example, the control of costs by the Department difficult, since there is no standard of comparison and overheads are difficult to calculate.

Some concern is also expressed by the Committee whether considerable facilities for research and development have been neglected. It is pointed out that even if a firm should not have full confidence in the integrity of the technical officers of the controls, this suspicious attitude should not necessarily prevent the acquisition of the information about its facilities for research and development required before a contract can be allotted. There are Government institutions, such as the Department of Scientific and Industrial Research, the permanent position of which in the service of the State places their impartiality above suspicion, and precedents exist for the use of these bodies where a firm is disinclined to disclose information to the officers of a Department.

The most serious criticism of the report, however, is that of the treatment of the paint industry, and the Select Committee considers that the system of lists adopted was neither economical nor fair. If it was considered that redundant paint-making capacity should be closed, there should have been a proper scheme as provided in the White Paper on concentration of production, with safeguards for the preservation of the commercial existence of closed firms and for compensation. Abandonment forthwith of the lists prepared by the Miscellaneous Chemical Control of paint firms where labour is protected, and to which Government departments confine their direct orders, is recommended.

The report thus affords some justification for the general criticism of the whole system of controls advanced by G. D. N. Worswick in "The Raw Material Controls" (Fabian Tract Series, No. 257. 4*d*.). Mr. Worswick traces the weaknesses of the controls, particularly in planning and lack of foresight, to the staffing of the controls with those already fully conversant with the industry or trade concerned. He argues that the qualities required of a good controller are much the same as those required of a good Minister: intelligence, the ability to grasp quickly the nature of a problem, and the determination to carry out any policy that has been decided. The controller must, of course, have his advisory team of experts, industrial and technical; but what is above all essential in the controller is impartiality and independence of the traditional background of the particular industry and trade. Mr. Worswick argues further that the controls are an essential part of reconstruction, where they should form part of a new branch of government charged with the provision of all the principal industrial raw materials, and the production of substitutes if natural supplies are no longer available. For this purpose three principles are laid down for staffing the controls. First, the head of each control should have no past, present or probable future financial interest whatever in the material he is controlling. Secondly, the use of existing trade organizations as controls should be abolished altogether; and thirdly, the controller should be employed on a terminable contract, say, for five years. To secure the best men, Mr. Worswick suggests that it may be necessary to pay the controllers on the industrial rather than on the Civil Service scale.

In his emphasis on the question of staff and on policy, rather than on the exact nature of the organizational relation of government and industry, and even more on the ownership of industry, Mr. Worswick is

in line with the trend of a subsequent report by a Fabian Research Group "Government and Industry: A Framework for the Future" (Research Series, No. 83. Fabian Society. 6*d.*), though he does not lay the same stress on intelligence and information service as the latter report and that of the Select Committee. That function, however, is as vital as the question of staffing and the direction of policy. Unless the Ministry responsible for the controls is well informed, it will not be able either to give guidance on principles of policy which will be commonly applied over the whole field of industry, agriculture and commerce, or indeed to decide on those principles and secure their application.

The review of the war-time controls in this Fabian Research Group report emphasizes that through the controls the Government has gained a far greater knowledge of industry than it had before. This in itself is a valuable asset in devising economic policy, and the reference in the White Paper on Employment Policy to the need for exact quantitative information about current economic movements suggests that the Government is unlikely to throw this away, whatever further means of supplementing it are required. The general supervision by the Government over most of the larger industries established in war-time has proved its value, and has indicated a means by which public policy can make itself felt in the fields of new investment, location of factories, research and development, labour management and labour policy and export policy, independent of the question of private or public ownership. The equity and desirability of such public control has been recognized in numerous statements in the last two years, such as that of Nuffield College on "Employment Policy and Organization of Industry after the War". Recent criticism of the Government has, in fact, centred on the failure of the Board of Trade to give the guidance which industry requires to make its concrete plans for serving the ends of both public and private policy.

The specific proposals of the Fabian pamphlet on "Government and Industry" are simple. A single central authority, specializing in such subjects as cartels, monopolies and restrictive practices, and the location of industry, and building up gradually a body of knowledge and technique, will be an indispensable part of the Government machine. Accordingly, in addition to a permanent buying Ministry to organize the whole of the Government's purchases from, and orders to, industry, there should be a central department for industrial control. This suggested department should be provided with expert sections to supervise all the great industries, whether fully nationalized or not, and should have a series of specialist bodies attached. Thus reinforced, the Board of Trade or Ministry of Industry would act as the final authority on the location of industry, the policy of monopolies and large-scale economic units, management, research and so forth. Again, while trade associations have legitimate functions to perform, they should not be allowed to exercise restrictive powers—a conclusion also reached by the Organization of Industry Committee of the Federation of British Industries in its recent report on the organization of industry in Britain. The Government must therefore have an organization separate from the trade association, through which to control the development of an industry, and to ensure that essential tasks, such as research, standardization, reorganization, export marketing and so forth, are adequately performed.

For this purpose, the Fabian Society's report proposes a series of development boards, not themselves trading bodies, but attached to individual industries and responsible to the section of the Board of Trade concerned with the industry in question. The scheme presupposes a central planning authority in the monetary and financial field, and the report recognizes that a good deal of industrial and managerial skill will be required. The system would make the fullest use of technical men and of business men, its success depending on the extent to which the appropriate administrative ability, impartiality and initiative, rather than technical knowledge, could be recruited. These, as Mr. Worswick stresses, are the ultimate safeguards against bureaucracy and the assurance of positive rather than negative control.

To the Fabian Society's Group, it is true, control still seems to be an end in itself. The committee recognizes the fruitful partnership between the State and industry which we have seen in our war-time arrangements at their best; and the admission that policy and quality of staff rather than sweeping changes in the present ownership of industry are what is required should make possible a broad range of agreement on the methods and objectives of any necessary measure of Government intervention and planning from the centre. The emphasis, however, must be on the minimum of control and on its positiveness in character, as in the Prime Minister's statement in the House of Commons on November 16. It is within these limits that we should seek to discover the principles that should guide and inspire the Government's intervention in industry and decide its policy.

The report of the Select Committee, like that of the Fabian Society's Group, should at least help to get the right questions asked. Few have done more, in fact, than Mr. Herbert Morrison, who contributes a preface to the Fabian report, to clear away prejudices and stimulate constructive thinking on these questions of the relations between industry and the State, and the form which industrial organization must take after the War. None the less, it must be admitted that the idea of restrictionism is embedded as deeply in reports and proposals from the Left, such as the interim report of the Trade Union Congress on post-war reconstruction, as in parallel statements from the industrial side, and it is this idea of restriction, from whichever side, that constitutes the greatest danger to what is commonly implied in a policy of full employment and freedom from want.

The Prime Minister's statement on the continuance of the controls shows that the Government is fully cognizant of what is required, and should reassure

those who, while recognizing the necessity for continuing control, are concerned lest control may be continued for its own sake. Given the principle that control will only be continued where and for so long as the public interest demands, it is possible to evolve out of our war-time and earlier experience the type and kind of control to suit our purposes. These purposes and needs will vary from industry to industry and with the national situation, but there is no reason to doubt the ability of Great Britain to develop a framework of government and industry sufficiently flexible to serve those needs and to foster enterprise and efficiency while securing the essential measure of public control. That involves, as Mr. Morrison and others have indicated, experimenting with different types and degrees of State control over industry, varying from public ownership and operation to a limited degree of control of prices and practices exercised from outside. It involves an intelligence service—or liaison or public relations service, call it what you will—adequate to ensure that the control is always in touch with the local or specialized needs of industries or communities. The joint production committees represent only one aspect of the way in which such public relations work must develop, and no section of a ministry to which the controls are entrusted is likely to be more important than its public relations department. Undoubtedly it will also involve special attention to the questions of recruitment and training of staff.

For all this, the war-time controls can provide only a part of the basic experience required. Beyond such experiment lie the vital factors of policy and of men, as so clearly indicated in the reports mentioned above.

Whatever machinery is devised, there must be the clear enunciation of policy at the centre. The execution of that policy must be entrusted to men who, whether drawn from the Civil Service or from industry, possess the administrative ability and initiative, the imagination and vision, and the impartiality and integrity to ensure that the nation's purposes are fully served.

## BIRDS AND THE CAMERA

### Birds of the Day

By Eric J. Hosking and Cyril W. Newberry. Pp. 128 (78 plates). (London and Glasgow: Wm. Collins, Sons and Co., Ltd., 1944.) 12*s*. 6*d*. net.

THERE is a well-known saying that great things arise from small beginnings, and this is true of modern bird photography, which began in those seemingly remote days when a stand camera was the only instrument for all types of photography. There is some dispute as to who took the first wild-life photographs. The names of Riley Fortune, Oliver Lodge and C. J. King, of the Scilly Isles, are among those of the pioneers. They worked with their heads under a black cloth, and their plates were so slow that they could only give a really fast exposure under exceptionally good lighting conditions. Yet they achieved some remarkable results, and when the Kearton brothers perfected the system of working from a hide, nature photography, and in particular the photography of birds, made rapid strides and attained wide popularity.

To-day those who practise bird photography and use their camera to record details of bird behaviour are beyond counting; but none of them has used his camera with better results than Mr. Eric Hosking, whose studies of birds are well known for their interest and beauty. Some of them are snapshots in the fullest sense of the word; for example, a picture in this, his latest book, of a marsh harrier alighting on its nest. The camera has caught it with wings raised in a pose as exquisite as that of a tern; while others are perfect portraits, models of exactness and of accurate rendering of every feather detail.

"Birds of the Day" is the joint work of Mr. Hosking and Mr. Cyril Newberry, the first named being responsible for the pictures of the forty or so species here dealt with, and the latter contributing much field work and descriptive matter. The descriptions vary from short paragraphs in the case of the blackbird and the song thrush to several pages in the case of the marsh harrier and the bittern, perhaps two of the most interesting birds found in Britain to-day. If this is termed a picture book we feel sure the authors will not cavil, for it is obvious the work of the pen is subsidiary to that of the camera.

The subjects are not treated in any special order or sequence, and are limited only to "Birds of the Day". Owls, we understand, are to be dealt with separately later on; however, an example of modern flashlight photography is given in this collection, namely, the portrait of a jackdaw at its nest in an old mill. The introduction of the soundless, odourless flash bulb has placed a most useful tool at the disposal of wild-life photographers. As examples of camera portraiture of birds the two very charming pictures of a male and female bearded tit, the latter with two dragonflies in her beak, perched on the reeds are indeed excellent, even if we long to see the cock depicted in all the beauty of his sandy-red and R.A.F. blue plumage, enhanced by the orange-yellow of his eye and beak, and set off by the black of his moustachial stripes. However, the extended use of colour photography in the ornithological field is coming fast.

For a useful record of bird-behaviour, combined with fine portraiture, the description of the greenshank carrying off hatched egg-shells from the nest and the accompanying illustration are particularly good. The authors tell us that a hiding tent had been in position beside the greenshank's nest for some days, but when the photographer arrived one morning he found the nest empty, only hatched shells remaining; however, he entered the tent and waited results. Before long "the hen greenshank came back, settled over the empty egg-shells, and began to rake them under her. Presently, in response to a soft call from the hen, the chicks came out of hiding in the grass and made their separate ways back to the nest, but the hen was preoccupied with the pieces of eggshell and paid more attention to them than to the chicks . . . she was restless and, after a little while, picked up a piece of shell with her bill and flew away, dropping it in flight . . . gradually all the shell was removed and the chicks came in for their full share of maternal devotion".

Seeing that greenshank chicks leave the nest within a short while of hatching, it is difficult to suggest what purpose, if any, there is in tidying up the nest. It is such observations as these that add value to the work of bird photography. FRANCES PITT.

# THE CHARM OF FLOWERS

## Flowers in Britain

Wild, Ornamental and Economic, and some Relatives in Other Lands. By L. J. F. Brimble. Pp. x+394+18 plates. (London: Macmillan and Co., Ltd., 1944.) 12*s*. 6*d*. net.

ONCE in a while a book appears which impresses the reader from the moment he first handles it. For a long time he has been conscious of a gap in contemporary literature that cries out to be filled; eventually a book appears, and the reader is immediately aware that this is the book for which he has been waiting. "Flowers in Britain" is unquestionably such a book. It was conceived with vision and has been nurtured with the assurance that such a book was badly needed.

Mr. Brimble has prepared it for "anyone who is interested in or wants to know something about flowering plants". These can be broadly divided into two groups. They are the non-botanists, who are interested in flowers for their appearance as much as anything else, and the botanists, who, while equally appreciative of the beauty of flowers, are more concerned with the formal aspects of their study. This book has something to offer to both groups, as well as to the intermediates who could not be classified as belonging to either one or the other.

British people have long had the reputation of being interested in their countryside. We have had striking proof of this during the War by the formation of natural history and field survey clubs in semi-static units of the Armed Forces, both at home and overseas. One such club in the Middle East has achieved considerable prominence, while, in Great Britain, the Royal Society has sponsored a promising movement in the Anti-Aircraft Command called the Nature Observation Scheme. The transfer of town-dwellers to rural areas, as well as the invasion of Great Britain by men from abroad who have made us more aware of the beauty of our own surroundings, has also served to deepen the regard for wild life. (Not many years ago, M. Herriot, the distinguished French statesman, was a guest in Oxford. He was asked by H. A. L. Fisher what had struck him most on this his first visit to England. "Two things," he replied, "first your rabbits and second your flowers.") Some of these people have particular interest in flowering plants, and to them this book would be a rich store of delight.

What has Mr. Brimble to offer here to the botanist? In the preface he writes: "One frequently finds that academic botanists, though thoroughly well-versed in the classification, structure, function, and so forth of the British native flora, are unfamiliar with garden flowers, many of which are really exotics. It is sometimes a matter of wonder to a non-botanist that many academic botanists, even those who have taken a university degree in the subject, know much less about the flowers of our gardens than the ordinary gardener". There is little need to labour his point, and many botanists will be grateful for the section on ornamental plants which appears under each family.

The order of the book can be briefly stated. There is a short introduction on the structure and classification of flowering plants, and then a series of chapters on the natural families, arranged, more or less, in evolutionary sequence. Each family is treated under the headings of plants indigenous to Great Britain, ornamental plants, and economic plants. The text is reinforced by more than thirty line drawings—all of them prepared by the author—and 160 photographs, and 18 coloured plates. The plates were painted by eminent floral artists; they are a tribute to their calling and to that of the printers who have prepared the plates for this work. Finally, the author has not forgotten the time-honoured part played by flowers in literature, and the book abounds with quotations as apt as they are entrancing.

In reading this well-merited praise, however, it must not be imagined that the book is without fault. Presumably, in trying to make the matter as clear as possible for the non-professional, Mr. Brimble has, on several occasions, fallen into the habit of 'writing down' to his reader. This has resulted in the production of some loose and grammatically unacceptable phrasing which might have been eliminated by severer proof-checking. There are a few factual errors, while, in some cases, the author has attributed to plants purpose and design. Further, some of the black-and-white photographs are not sufficiently clearly printed to illustrate the point under consideration.

Yet the standard of the book makes these criticisms seem almost churlish or carping. It is a magnificent production which should add considerably to the author's growing reputation as a writer of general biological works. When the next edition is printed, it is to be hoped that the supply position will have so much improved that the paper on which the text is printed becomes worthy of the matter.

T. H. HAWKINS.

# FOOD SCIENCE

## The Chemistry and Technology of Food and Food Products

Prepared by a Group of Specialists under the editorship of Dr. Morris B. Jacobs. Vol. 1. Pp. xvi+952. (New York: Interscience Publishers, Inc., 1944.) 10.50 dollars.

DR. MORRIS B. JACOBS, with the aid of forty-one expert collaborators, has set out to write a text-book in two volumes covering the whole field of food science and technology—a difficult if not an impossible task. Volume 1 is in two parts and contains 900 pages of subject-matter. Part 1 occupies 390 pages and is concerned with fundamentals—the physical chemistry of foods, the carbohydrates, lipoids, amino-acids and proteins, enzymes, vitamins and minerals, colouring matters, food spoilage and poisoning. All the sections are well written and largely up to date, and no doubt there are few research workers who would not profit by reading them. At the same time, many will feel that it is rather an unnecessarily heavy and rich hors-d'œuvre for the massive courses that follow.

Part 2, on foods, covers milk and dairy products, meats, fish, poultry and eggs, edible oils and fats, cereals, baking, fruits and vegetables, carbohydrates, confectionery and cocoa products, flavours, spices and condiments, coffee and tea. Each of these commodities is treated by an expert in the particular field, some of them of international renown. At the same time they are all very busy people, and one cannot help feeling that they would have written even better articles after the War when the demands on their time will be reduced.

In evaluating Volume 1 it is essential to remember

what Volume 2 will contain. We are told that it will be in four parts dealing with unit-operations and processes, sanitary and quality control, methods of preparation and methods of production. Dr. Jacobs, in his preface to Volume 1, points out that a certain amount of overlapping of the subject-matter is inevitable. Some of this could have been avoided; it is irritating, for example, to find canning and gas storage dealt with to the extent of about 200 words each, when presumably they will be considered in detail somewhere in Volume 2. For the same reason, it is difficult to criticize Volume 1 from, say, the points of view of omissions or meagreness in detail, not knowing what the next volume will contain.

The general level of the sections on foods in the volume under review is, as would be expected, excellent. The treatment of dairy products is obviously relatively meagre; but this is subject to the qualification in the preceding paragraph. The section on meat products deals sparingly with the changes in rigor mortis but compensates for this by a succinct and excellent statement on muscle pigments. Some readers will detect a touch of the quixotic in the statement that the 'drip' from frozen meat is dependent upon the duration of storage but is apparently unaffected by the temperature of storage. Others will be eager to know more about the asphalt treatment of hams and bacon. Dr. Mary Pennington discusses poultry and eggs with authority and experience, and will intrigue the reader with her reference to the fact that wax picking of poultry—the removal of feathers simply by dipping the birds in melted wax and stripping off the solidified wax—has now been supplemented by a "rubber finger picking machine" which removes most of the body feathers before the wax treatment. The sections on cereals and baking are outstanding. Prof. Geddes, however, does not mention the considerable difference in the riboflavin values found for cereal products in the United States and Great Britain; also his calculation that 12–15 per cent of germ is required to raise the vitamin $B_1$ level of patent flour to whole-wheat level applies only to the embryo fraction of the germ and ignores the two years old work in Britain which revealed the high content of vitamin $B_1$ in the scutellum fraction of the germ.

Two general criticisms can be levelled at the book. In the first place, it is disturbing that so many references are made to other published *books* and not to original papers. This fact not only tends to reduce the value of the book to the research worker but also raises doubt that a piece of original research is dealt with correctly and adequately. A further outstanding point is that the bulk of the references—perhaps more than 90 per cent—refer to American and Canadian work. It is hard to believe that the published work of the Food Investigation Board, the dairy research institutes, the food research associations and commercial laboratories in Great Britain merits less than 10 per cent of the references. There must be an explanation. Possibly it would help if we had one or two recognized journals for the publication of papers dealing directly with investigations in food technology—comparable with, say, *Food Research* or *Cereal Chemistry*. Whatever the solution, it is a challenging problem.

It is easy to criticize, and, having said that, let it also be acknowledged that this is probably the best book that has yet been written on food science and technology.

T. MORAN.

# THE ADVANCE OF BIOCHEMISTRY

## Annual Review of Biochemistry

James Murray Luck, Editor; James H. C. Smith, Associate Editor. Vol. 13. Pp. ix+795. (Stanford University P.O., Calif.: Annual Reviews, Inc., 1944.) 5 dollars.

IN his story of his visit to India, which has so arrested the attention of all of us, Prof. A. V. Hill has emphasized the need for biological research in particular in order to solve the many complex Indian problems.

The "Annual Review" may serve as an indication of the extent to which chemistry is allied with biology in the urge to extend knowledge. The findings are being far more rapidly applied to public welfare than of yore—in medicine, in food, in hygiene and in agriculture. If it be accepted that chemistry is the basic science, which has discovered how things are composed, what properties they have and how they will react, while physics provides an explanation of the rules of the chemical game, then the chemist must pioneer in the study of substances of physiological importance. He must know their structure, their properties and be able to explain the very complex reactions in which they take part. His difficulty has been, and is, to obtain them in sufficient quantity or of satisfactory purity for his purely chemical studies, so that real progress has had to wait on advances in laboratory technique as, for example, microchemical analysis, separation by selective adsorption.

The past decade has been fruitful in such methods, and progress has been the more rapid in consequence. It must be realized that a high standard of manipulative skill is required from the biochemist; further, that he is responsible for the soundness of his work, so that hasty publication is to be deplored.

In fact, the yearly output of biochemical papers is so great that no one can master even a tithe of them, nor indeed would his time be profitably employed. Hence the ever-increasing value of the "Annual Review of Biochemistry", now issued for the thirteenth time by Messrs. Luck and Smith, to whom all workers owe a very profound expression of thanks. For us in Britain it is the sixth winter of war and no such publication of eight hundred well-printed pages would be possible: our American cousins are more fortunate in escaping, or perhaps overcoming, the usual difficulties attendant upon the War, but our envy takes a very mild form, for we share on equal terms their gift to biochemists and are indeed grateful.

The 1944 volume takes its usual form, the subject being broken up into twenty-six sections, some of which are the joint responsibility of two authors. The standard throughout is high; the articles as a whole are more readable and less a catalogue of specialist progress.

The complex carbohydrates do not lose their attraction and are the subject of an admirable review by W. Z. Hassid. Those who listened to Prof. W. N. Haworth's very lucid Bakerian Lecture before the Royal Society know how apparently simple this complex subject can be made to appear; Dr. Hassid is almost as successful. One leaves the article wondering why Nature had to be so involved in creating such complexity from simple starting materials.

The proteins and amino-acids are no less important to-day, and their study, particularly that of the structure of the intact protein molecule, is returning

to fashion. Attention is perhaps focused on the preparation of proteins possessing unique and specific biological properties, that is, enzymes, hormones, viruses and immune bodies. Phosphorus compounds receive a special section commensurate with the increasing recognition of the part they play in reactions *in vivo*. Last year, sapogenins and saponins were reviewed under the heading of steroids; this year's story is limited to recent work on bile acids, sterols and steroid hormones. These are most complex substances; they play an important and universal part in living tissues.

Metabolism is broken up into many sections. The painstaking accumulation of facts and their verification is step by step contributing to progress—the significance of what are called trace elements in mineral metabolism is becoming more and more clear. Apparently the land animal of to-day has not entirely forgotten that it was once in bygone ages a marine organism.

The subjects of hormones and vitamins attract as much interest as ever, though the number of references quoted is not so large. Great interest is attached to the reports on nutrition and on nutritional deficiencies in farm animals. The War has both focused attention on such questions and given added stimulus to their study.

There is a well-written section on alkaloids by R. H. F. Manske : there seems to be no end to these compounds, and it is to be hoped that before long their inter-relationships and meaning will become clear. Even more interesting is the chapter by F. F. Blicke on synthetic drugs. The spectacular progress of chemotherapy has attracted the attention of the public at large, who are benefiting to-day from the drugs very soon after their discovery. Naturally fungi also require a section, written by E. L. Tatum. The discovery of penicillin has raised popular hopes that other moulds may contain a host of other specifics; but this article is severely scientific and more interested in a tentative interpretation of the biogenetic relationships of the mould products. All must ultimately have come from sugar and they represent end-products of carbohydrate metabolism; they belong to a rather limited number of chemical groups.

Only a very cursory survey of some of the reviews has been attempted, with the object of showing how much there is in the volume, which even at the risk of repeating what has been said in other years is once more certainly indispensable.

E. F. ARMSTRONG.

## PHYSICS AND PHILOSOPHY

### Physics of the 20th Century

By Pascual Jordan. Translated by Eleanor Oshry. Pp. xii+185. (New York: Philosophical Library, Inc., 1944.) 4 dollars.

THE story of the rise and development of twentieth century physics has been told so often and by so many 'leading world authorities', that, fascinating as it is, one's first reaction to any further author who proposes to guide the footsteps of the 'layman' along the now well-worn and familiar track is to ask (perhaps a little ungraciously): "Is your journey *really* necessary ? Have you some points of view of interest to disclose which your predecessors have missed, or some matters of moment to discuss which others have, perhaps, insufficiently considered ?" It may be said at once that, in the case of Dr. Jordan, the answer is definitely in the affirmative. While some authors have dealt more fully, and perhaps more clearly, with the experimental discoveries upon which the concepts of the new physics are based, and others have expatiated on the impact of these discoveries on industry, commerce and the social order, to Dr. Jordan the main interest of the story is in its intellectual content; to him it is primarily a spiritual adventure. "Our most wonderful moments of scientific evolution," he writes in his preface, "are experienced when it is shown that we must revise our ideas from the ground up to agree with a new concept. Modern physics effected many such changes; and in the most fundamental respects. That is what this book would like to tell about."

The 'layman' to whom Dr. Jordan addresses himself is thus not so much the scientist *manqué* as the philosopher, whether amateur or professional, who may wish to consider what bearing, if any, the new concepts of twentieth century physics may have on his own particular interests. It is true that philosophers have not so far shown quite as much interest in modern physics as some modern physicists have shown towards philosophy, and it may be readily admitted (as, in fact, the author does admit) that neither the methods nor the ultimate objectives of philosophy are those of physics. It is equally true, however, that even the most abstract philosopher can scarcely escape the intellectual atmosphere of the times in which he lives. There can be no doubt, for example, that the rise of dialectic materialism was largely aided and abetted by the existence of the 'mechanistic' school of physicists, who imagined (quite erroneously as it appears to us to-day) that, given the co-ordinates and momenta of all the atoms in the universe, it would be possible for a competent college of mathematicians to calculate all past and future history. The gradual abandonment by physics of the 'mechanistic' point of view, and the reasons which made this change of viewpoint inevitable, form the subject-matter of the present volume.

As far as may be, the author has endeavoured to present an unbiased and objective account both of the progress and the conclusions of modern physics, and has confined himself to indicating the particular points at which they appear to impact upon the conclusions of philosophy and theology. While it is, of course, well known that Dr. Jordan has his own ideas on the subject, he does not, in the present volume, intrude them upon the reader; or commit the tactical error of putting up the back of the philosopher by attempting to do his work for him.

It is unfortunate that the effect of the book in its English dress (it is a translation) should be marred by a rather involved style, and some infelicities and even obscurities in diction. How far this is due to the original manuscript, one cannot say; but only too often the translator appears to have been satisfied to transliterate the author rather than to try to present his ideas in current English; so that the unfortunate reader is left to wrestle simultaneously with unfamiliar ideas and a foreign idiom. The book, however, is one of real distinction; and readers interested in the fundamental problems and ideas of which it treats will be well advised to make the effort. Its appearance at the present time serves as a useful reminder that twentieth century physics is not solely, or even mainly, concerned with the gratification of the national animosities or material desires of mankind: it has a specific contribution to make to the ocean of universal learning.

# MOUNTAINS THAT HAVE TRAVELLED OVER VOLCANOES*

By DR. E. B. BAILEY, F.R.S.
Geological Survey of Great Britain

## Contrasts of Facies of Contemporaneous Formations in the Alps

GEOLOGICAL formations may vary greatly in character, or facies, from place to place. In the Swiss Alps the Mesozoic sediments show several facies associations, sufficiently definite to be given names. Of these the most commonly encountered is called Helvetian, while another of more restricted occurrence is called the Klippe facies. The name Klippe is taken from the German word for a cliff, because this particular facies is well displayed in some cliff-bounded mountains which form a conspicuous scenic element in the neighbourhood of Lake Lucerne. Equivalent formations exhibiting the Helvetian and Klippe facies are often so completely different in appearance that no one would guess their contemporaneity were it not for their contained fossils. This is truly amazing because the two facies in many localities lie cheek by jowl.

Bernhard Studer did more than anyone else to gather the facts. He found so early as 1834 that the Klippe facies was represented by the rocks of a considerable continuous mountainous area, later christened the Préalpes romandes, which reaches from near Geneva north-eastwards to Lake Thun; and also that it reappears in a surprisingly big proportion of boulders and pebbles contained in Early and Mid Kainozoic sediments along the northern face of the Alps. He deduced therefrom, quite correctly, that the Prealps represent the remains of a northern marginal chain which was being subjected to erosion in Early Kainozoic times. He further assumed, as a matter of course, that this chain had risen from below in the district where its remnants are still recognizable; and that its frequent non-appearance at the surface depends upon burial, partly beneath its own accumulated debris and partly under folds of Helvetian facies that have travelled a little distance from the south. Studer's conception failed to account for the abrupt change of facies, met, for example, on crossing the margin of the Prealps. It also contradicted every field observation of the structural relationships of Klippe and Helvetian complexes, for universally the Klippe complexes present the appearance of resting on top, not rising from below (Fig. 1). Still, it was the only interpretation that could be offered without invoking large-scale over-thrusting, and for this reason it remained all but unchallenged for fifty-nine long years.

In 1893 enlightenment came to Hans Schardt, who for the past fourteen years had been groping in the semi-darkness of the times trying to solve some of the riddles presented by the Prealps. Suddenly, he found himself standing in a flood of light which illuminated, not only the present position of the chain, but also the history of its development. There before him stretched the Prealps, a complex of Mesozoic and Kainozoic formations, entirely underlain by the local Kainozoic; an immigrant countryside fashioned of alien rocks that bespeak a southern origin; an erratic, as truly as any of the great blocks of Mont Blanc granite which we find jettisoned by vanished glaciers upon the flanks of the Juras—but an erratic, 75 miles long and 25 miles broad!

The Prealps are a composite erratic formed of a succession of superimposed thrust-masses. The higher thrust-masses have travelled farther from home than the lower, and each in turn has brought with it a distinctive stratigraphical facies. It was indeed the realization of the existence of multiple facies contrasts that cleared the way to understanding. Schardt had been brought up on Studer's two facies, Helvetian and Klippe, exposed side by side. The phenomenon was far too familiar to worry him as it really ought to have done. It therefore came as a mental shock and much-needed tonic to learn that Maurice Lugeon, through a find of fossils, had demonstrated another, and even more striking, facies contrast in the self-same area. Schardt realized at last that a far-travelled thrust-mass may often be recognized by the foreign characteristics of its rocks, just as a far-travelled man may often be recognized by the colour of his skin or the words of his speech. Bertrand, Suess and a few others had already looked for help in this direction; but the regular employment of facies as a tool in the disentanglement of mountain structure was introduced by Schardt's appreciation of its value in relation to the Prealps.

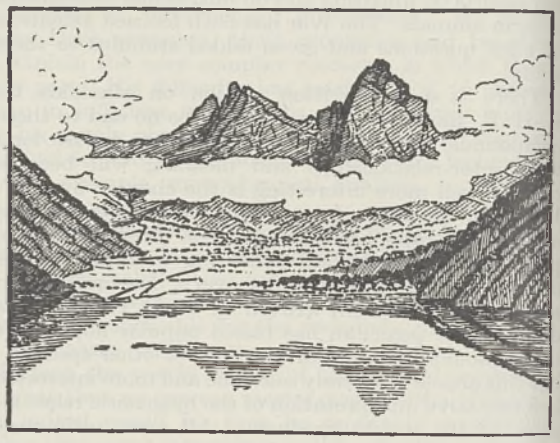


Fig. 1. THE MYTHEN FROM LAKE LUCERNE (AFTER ALBERT HEIM). This Klippe consists of Mesozoic rocks of Klippe facies. Heim has drawn a symbolic cloud to represent obscurities of pre-1893 interpretations. The grass below the cloud is on Kainozoic; from below on either hand emerge Mesozoic crags. All below the cloud is of Helvetian facies.

The controversial spirit that was aroused by Schardt's "Origine des Prealpes romandes"[1] was reminiscent of that stirred by Darwin's "Origin of Species"; but opposition soon gave place to co-operation, and the new opportunities opened up for research led to a sustained, brilliant and most fruitful attack, altogether without parallel in the history of geology, upon Alpine problems.

Before leaving Schardt and his Prealps let us note that his re-interpretation of Studer's Klippe-facies marginal chain, as a superstructure riding upon adjacent Kainozoics, enabled him to account for its manifest gaps by invoking erosion, pure and simple. Studer, it will be remembered, had had to supplement erosion with burial. Moreover, the Klippe-facies pebbles enclosed in the over-ridden Kainozoics justified Schardt in claiming that the postulated erosion actually started long before the thrust mountains had ceased to travel over the floor of the sea which then lay to the north of them.

* Extract from a Friday discourse delivered at the Royal Institution on November 3.

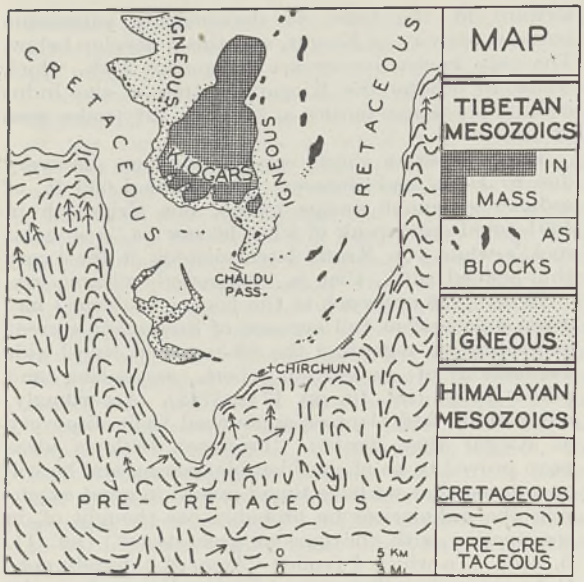



Fig. 2. Based on Arnold Heim and A. Gansser.

## Facies Contrast in India

From Alps to Himalayas is a comparatively easy journey for a geologist. Both chains form part of one continuous Kainozoic range that stretches from Spain to the Dutch Indies; and both are in large measure fashioned of uplifted marine sediments that accumulated in an ancestral Mediterranean Sea called by Suess the Tethys. These sediments are particularly well displayed in the north-western Himalayas, where they form a mountainous belt 500 miles long, lying north-east of, and parallel to, the main line of giant snow-clad summits. The Spiti Shales of Mid Mesozoic age are their best-known component formation. For many centuries beautifully preserved fossil ammonites from these shales have been sold as sacred relics in the holy places of India. Thus we find that long before any geologist had seen these fossils *in situ*, examples had been described and figured as type specimens of new species and genera.

We are here concerned almost wholly with the south-eastern part of the belt, where it forms the divide between the Upper Sutlej and the head waters of the Ganges, at the same time serving as mutual frontier to Tibet and India. Here in the Kiogar-Chirchun district, C. L. Griesbach, C. Diener and C. S. Middlemiss in 1892 made a momentous discovery[2]. They found two markedly distinct facies of Mesozoic and Upper Palæozoic sediments in close juxtaposition (Figs. 2, 3). The first of these is now styled the Himalayan facies. It is characteristic of the 500-mile-long belt as a whole and differs notably from that of any time-equivalent known in Europe. The second, as yet only recognized in the Kiogar-Chirchun district and its continuation to the east, is spoken of as the Tibetan facies. On certain horizons it is almost identical with a locally developed facies found in the Austrian and Bavarian Alps at Hallstat, Hallein and (tell it not at peace conferences) Berchtesgaden[3,4].

Griesbach and Diener were Austrian in origin, as also was A. von Krafft, who later visited Kiogar and whose 1902 description furnishes the main foundation of our present knowledge of the district. Griesbach was for long a member of the Geological Survey of India, rising eventually to be its director. Diener was a professor at Vienna, who described many fossils collected by the Survey besides those he himself secured during the 1892 Expedition; von Krafft, like Griesbach, was on the staff of the Survey, but only for a short period. He died in 1901 before the appearance of his wonderful memoir to which reference has just been made.

In the Kiogar region the sediments of Tibetan facies are usually found as extensive masses or isolated blocks, partly overlying, partly involved in, a thick complex layer of igneous rocks; while the sediments of Himalayan facies usually underlie this igneous layer and are arranged among themselves, broadly speaking, in normal succession. Obviously, to reach their present extraordinary situation the Tibetan sediments must have travelled considerably. Still Griesbach and Diener, though well aware as time went on of current discussion of facies contrasts presented by Klippes in the Carpathians and the Alps, never admitted that the Tibetan masses of Kiogar had travelled horizontally through any significant distance. They thought it enough to imagine that the Tibetan assemblage had been pushed up in some unusual fashion to furnish a fault-breccia, and they regarded its facies peculiarities as a mystery totally unconnected with its anomalous structural position[5-8]. On the other hand von Krafft, Suess and later participants have clearly recognized that the facies contrasts between the overlying Tibetan and underlying Himalayan successions denotes great horizontal travel of one in relation to the other. Von Krafft attributed this travel to volcanic activity, operating either through the force of explosions or through the floating agency of lava streams (ref. 3, pp. 170, 173); but Suess[9] and his successors have attributed it to over-thrusting of the same type as is manifested

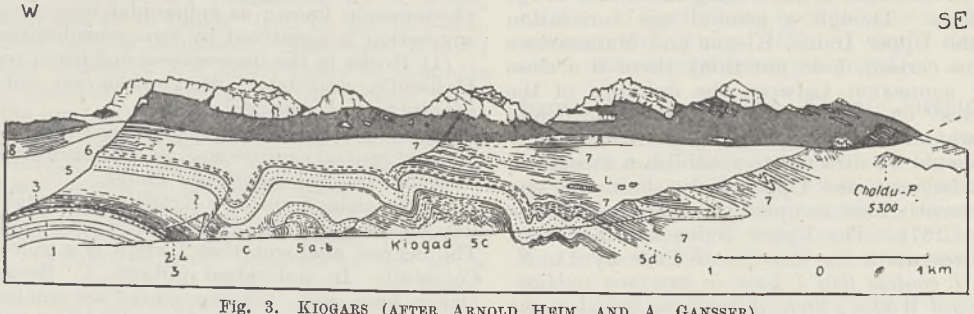



Fig. 3. Kiogars (after Arnold Heim and A. Gansser).
Summits: Tibetan Mesozoic sediments, mainly Pre-Cretaceous.
Intervening: Igneous complex (shaded).
Lower slopes: Himalayan Mesozoic sediments: 1–4, Pre-Cretaceous; 5–8, Cretaceous, with radiolarian chert constituting 8.

in so many other mountain chains. Naturally the advocates of over-thrusting have sought to provide room in their theories for the emplacement of the igneous complex that separates the Tibetan and Himalayan sediments. In this direction there has developed considerable diversity of opinion.

## Igneous Rocks of Kiogar

Before discussing any of the rival Kiogar theories, it will be as well to enter into a little more detail regarding some of the rocks of the district. In doing so I shall avail myself in the main of von Krafft's observations, but shall accept certain important modifications recently introduced by Arnold Heim and August Gansser. The former, son of the distinguished geologist, Albert Heim, was brought up to geology from the cradle. His very name, Arnold, at once recalls his father's reverence for the great pioneer, Arnold Escher von der Linth. In 1935 Heim junior visited me in Glasgow, and I had the great pleasure of hearing of his preparations for an expedition to the Himalayas. In return I told him how I had been led to modify in an important detail Suess's interpretation of the Kiogar district, and I urged him to include this wonderful locality in his itinerary. Next summer, while I was assisting in the celebration of Harvard's tercentenary by propounding my story of mountains that have travelled over volcanoes[10], Heim and Gansser were hammering new facts out of these same mountains, to the great advantage of our science.

The topmost Tethys sediments of Himalayan facies in the Kiogar district belong to the Cretaceous System at the summit of the Mesozoic Group. The Lower Cretaceous is represented by some 2,000 ft. of greenish, glauconitic sandstone. Specimens from the Kiogar district, and also farther east, contain small fragments, which under the microscope are seen to correspond in type with lava-like constituents of the igneous complex lying at higher levels[11]. The Upper Cretaceous consists mainly of shales, for the first 2,000 ft., followed upwards by radiolarian cherts, amounting to another 1,000 ft. (von Krafft gives much smaller measurements).

I speak of these cherts as Upper Cretaceous, since such is the custom; but an early observation of Griesbach's near Dangpu, not far from the Sutlej, suggests that they may extend into the early Kainozoic[12]. Another interesting point to recall is that Griesbach, on first meeting with the associated igneous rocks, immediately and, as is generally agreed, correctly correlated them in a general way with other igneous occurrences already recorded by Strachey in 1851 at the Manasarowa Lakes and, much farther away, by F. Stoliczka in 1865 along the course of the Upper Indus. Though a general age correlation between the Upper Indus, Kiogar and Manasarowa rocks seems certain, I do not think there is a close structural connexion between the outcrops of the Upper Indus[13] on one hand and those of Kiogar and Manasarowa on the other. It looks rather as if research should be directed to establish a structural connexion between the Upper Indus belt and one that has recently been sampled by Gansser at Kailas (ref. 11, p. 187). The Upper Indus belt has been extended westwards to the Burzil Pass by D. N. Wadia[14]. *I confess that I have in previous publications employed Wadia's finds of fossils at Burzil on the misunderstanding that they came from the same structural position as is represented at Kiogar.* Fortunately there remains other evidence, which I could have put forward at the time, to demonstrate submarine volcanic activity at Kiogar, and this I develop below. The only known occurrence of igneous rock, which seems to occupy the Kiogar position in the Indus area, is a volcanic outlier in Zanskar, fifty miles west of Leh[15].

The radiolarian cherts constitute a new discovery due to Heim and Gansser. Of course 1,000 ft. of sediments cannot escape notice, but Griesbach in 1891 could only speak of what he saw as "a singular rock", while von Krafft later mistook it for "very thin-bedded tuff", that is, compacted volcanic ash.

In my 1936 approach to the Kiogar problem I had given a somewhat full account of Steinmann's great generalization regarding the oft-repeated world-wide association of radiolarian chert, serpentine and pillow lavas* (ref. 10, pp. 1718–1722). Accordingly, when Heim and Gansser announced their discovery at Kiogar they wrote: "Professor Bailey's ideas have proved to be of considerable bearing and he will be amazed that we have found indeed in great extension the radiolarites he probably has thought of, in conjunction with the igneous greenstones" (ref. 11, p. 146). To which I replied "Amazed? Surely not! Only sorry that Steinmann did not live to hear the welcome news"[16]. Though far from amazed, I was naturally delighted. Heim and Gansser's great find had completed the expected trinity. Serpentine had long been recognized and described in the igneous complex of the Kiogar region by von Krafft, who had submitted his material for microscopic examination to his colleague Thomas Holland (ref. 3, p. 136). It is also known in great bulk, associated with wide stretches of undecomposed peridotite, to the north of the Kiogar heights and near the Manasarowa Lakes (Heim and Gansser, ref. 11, pp. 183 and 179). Pillow lavas, too, had been described by von Krafft at Kiogar, though lack of experience prevented him from recognizing their true nature. In his account von Krafft quotes from Holland's descriptions such remarks as: "most of the rocks present the characters of lava flows, generally basic in composition, but much too altered for precise determination", and "many are distinctly amygdaloidal". He then turns to field aspects of the igneous complex and tells, for example, how he has met on the screes "round balls of amydaloidal andesite, approximately 2 ft. in diameter", which "on being broken up were found to contain calcite kernels, large in the centre, and decreasing in size towards the periphery". "In two places I observed," he added, "a spheroidal or sack-like structure in solid lavas, no doubt the result of weathering" (ref. 3, p. 137, also pp. 159, 165). It will be noticed that von Krafft attributed the ball or sack (that is, pillow) structure to the familiar phenomenon known as spheroidal weathering. This suggestion is negatived by two considerations:

(1) Rocks in the decomposed condition recorded in Holland's, and later, descriptions do not develop spheroidal weathering[17];

(2) Spheroidal weathering does not lead to development of central cavities such as are represented by the "calcite kernels" mentioned above.

On the other hand, von Krafft's description irresistibly recalls many familiar occurrences of pillow lava. The nearest analogue that I know is a pillow lava in Cornwall. In individual pillows, C. Reid and H. Dewey have said, "the amygdules are smallest in the outermost layers, and decrease in number but

* Steinmann did not admit that what we others call pillow lavas are really extrusive; but this mistake of detail is dealt with sufficiently in my 1936 paper.

increase in size towards the interior. The centre is often highly vesicular, with a large cavity from which the infilling calcite has been weathered out"[18].

Naturally when Heim and Gansser's descriptions appeared I looked to see if they had anything to say of the two exposures in which von Krafft had noticed spheroidal lavas. One not far from the summit, Kiogar 5, is figured and described as follows: "Red chert with radiolarians and associated, more or less siliceous limestones and marls" with "flags occur in such abundance" in the igneous mass "that they form a kind of stratification" (ref. 11, p. 156; the locality corresponds with von Krafft's in ref. 3, p. 159).

The inference I draw from the above facts seems to me secure: volcanic activity started in the Tethys somewhere near Kiogar early in Cretaceous times, and provided a little ashy material to the Lower Cretaceous sandstone; later, following an important development of radiolarian cherts, the local Tethys volcanoes became much more active and poured out submarine lavas, some of which assumed pillow structure; radiolarian chert continued to be deposited during quiet intervals; serpentines were intruded.

The same general assemblage of igneous rocks as presents volcanic relations to the underlying Himalayan sediments presents intrusive relations to the overlying Tibetan sediments. It is not only the coarse-grained serpentines that behave intrusively, but also the fine-grained lava-like rocks. In many cases these latter traverse the Tibetan sediments as narrow veins. In others they enclose entire blocks. The veining affects all members of the Tibetan succession, including certain occurrences which Heim and Gansser refer to the Cretaceous period (ref. 11, p. 162).

## Rival Theories

(1) We have already noted von Krafft's theory of volcanic transport of the Kiogar masses of Tibetan facies. He supports it by reciting many described examples of sedimentary material enclosed in volcanic ashes in other parts of the world; but he frankly admits that he has found no record of anything approaching the Kiogar scale (ref. 3, pp. 170, 173). Von Krafft's own descriptions and illustrations emphasize this difficulty of scale so clearly that as yet no one seems to have accepted his interpretation. Heim and Gansser, who have examined the ground, report that "the Kiogar limestone extends over many square kilometers, and permits to recognize its stratification over considerable distances", and also "the Kiogars are the remains of a thrust sheet coming from the Tibetan side, as already supposed in spite of v. Krafft's contradictory conclusions by E. Suess, F. Kossmat and E. B. Bailey" (ref. 11, pp. 160, 161).

(2) Suess, as just mentioned, interpreted in 1904 the Kiogar sediments of Tibetan facies as remnants of a far-travelled thrust-mass. He further interpreted the igneous complex that intervenes between the postulated thrust-mass and its Himalayan foundation as having been injected in this position during the forward progress of the thrust-mass.

(3) I was attracted to von Krafft's memoir by Suess, as presented in de Margeries' edition, "La face de la terre"[19], enriched with illustrations not to be found in the original of "Das Antlitz der Erde". I felt that Suess was in the main correct, but that he had overlooked an important aspect of the igneous complex, namely, that it includes representatives of submarine lavas as well as of subterranean intrusions. "I take it," I wrote in 1936, "that a Tibetan nappe has passed over a line of active submarine volcanoes; and that thereafter, for a while, magma has flowed along the thrust at the base of the nappe; but whether or not the original volcanoes were fed from a thrust plane has not been decided" (ref. 10, p. 1723). The above exactly expresses my present position after studying the host of new facts brought to light by the researches of Heim and Gansser. I consider that the Kiogar region furnishes the most remarkable geological monument in the world. It shows a Tibetan thrust-mass, which in its advance closed the mouths of Himalayan submarine volcanoes, and got itself riddled with multiple injections as a natural consequence. It combines the phenomenon of far-travelled facies, which Schardt illuminated in his 1893 interpretation of the Prealps, with that of tectonic smothering of vulcanicity, a conception sufficiently thought-provoking in itself.

(4) Heim and Gansser have advanced another variety of the volcano plus thrust theory. They consider that lavas and intrusions developed in late Cretaceous or early Kainozoic* times "in a remote Tibetan zone on the south side of the Trans-himalaya at the bottom of the deep sea and below it. Blocks slipped down from the coast and were embedded in the igneous flows. Then followed the thrusting towards the south" (ref. 11, p. 163). I do not think that the authors are likely to retain this "preliminary view", as they call it, because it is scarcely in accord with all the evidence they themselves have marshalled. They have been led to interpret the volcanic rocks, and many of the intrusions, as part of the far-travelled Tibetan thrust-mass, because they have found the igneous rocks in certain cases obviously affected by movement; and yet they are satisfied that the serpentines, though also obviously affected by movement, are quite certainly intruded into the Himalayan Cretaceous (ref. 11, pp. 184, 185). Similarly, in dissociating the volcanic rocks from the Himalayan suite and attaching them to the Tibetan suite, Heim and Gansser seem to forget that they have found debris of similar rock types in the Himalayan Lower Cretaceous sandstone. Moreover, they are driven to interpreting the radiolarian cherts between the lavas as Tibetan in contrast with the radiolarian cherts below the lavas, which latter they class as Himalayan. Regarding the cherts between the lavas they say: "The igneous flows must have been in relation to the deposition of the youngest sediments of the region which are regarded as Upper Cretaceous deep sea deposits. In the south-eastern Kiogars both are even mixed in a way as if the flow had penetrated and imbibed the flysch series [cherts in this case] chiefly along the bedding planes as it could hardly have been the case at the subaerial surface" (ref. 11, p. 162). I could name various other difficulties if space permitted.

## Exotic Blocks of the Kiogar-Chirchun District

In sketching the conditions prevailing in the Kiogar region, I have up to now avoided reference to the fact that many blocks of Tibetan sediment, together with associated igneous material, occur embedded in the Himalayan Cretaceous shales. The phenomenon of exotic blocks† enclosed in stay-at-home over-

* Elsewhere they (or probably only Gansser) claim these rocks as pre-Cretaceous (ref. 11, p. 184).

† The Tibetan blocks enclosed in the igneous complex are quite rightly called exotic blocks, but I have already discussed their relationships. Here I am only concerned with exotic blocks enclosed in sediments of Himalayan Cretaceous.

ridden sediments is one that is thoroughly familiar to students of the Alps. Again and again the question arises: Was this particular block introduced by sedimentary processes, such as land-slipping assisted by tunamis (earthquake-generated sea-waves), or by mechanical processes more directly connected with the operation of thrusting? In the present district there is, south-west of the Chaldu Pass (Fig. 2), a very prominent set of Tibetan sedimentary blocks, with Lias lettered L in Fig. 3. They are linked together by the customary igneous complex, including at one place pillow lavas, so as to constitute a unit three miles long, which has been carefully discussed by von Krafft under the heading "Area South of Kiogar Plateau" (ref. 3, p. 162). Though von Krafft was much averse to receiving aid from earth movement in his major problem, he clearly realized that the emplacement of this conspicuous assemblage of Tibetan and igneous rocks in the heart of the Himalayan Cretaceous sediments must be ascribed to folding and thrusting of some sort. Heim and Gansser confirmed this opinion and, calling the whole the "Chirchun thrust sheet", described it in architectural terms as a "tectonically lower exotic story", standing well below the main exotic story represented by the thrust-sheet that caps the Kiogar summits (ref. 11, p. 159). Several other exotic blocks included in the Cretaceous sediments of the district have been ascribed by the same three authors to mechanical introduction, and in all cases I agree.

In reading of these occurrences I have come to wonder whether the mechanism involved has not mostly depended upon outward flow of the unconsolidated Cretaceous clays when these have found themselves unevenly loaded by the advance of the Tibetan thrust-mass. Movement of clay under unequally distributed load is known to every civil engineer. Let me recall three representative examples.

(1) The Glengarnock iron foundry in Ayrshire piled up a great heap of slag on a clay surface. Presently the bottom of a neighbouring lake slowly rose and exposed the pile foundations of a forgotten crannog (lake village).

(2) Members of the Geological Survey have recently published detailed descriptions of adjustments by flow and rupture which have occurred again and again in response to changes of load dependent upon the protracted erosion of the valley systems of the counties of Northampton, Rutland and Lincoln. The main clay involved belongs to the Liassic formation of Mid Mesozoic age[20].

(3) At the foot of Beachy Head, the Chalk of the 500-ft. cliff is underlain by Upper Greensand and mobile Gault Clay, all three belonging to the Cretaceous System. Most of the chalk lies undisturbed; but its bottom portion, together with the greensand and gault, shows wonderfully complicated repeated small-scale thrusting, presumably due to outward upward flow of the yielding clay. The movement thus recorded very probably followed upon the marine erosion that has cut the present-day cliff (for the observational facts see Clement Reid, 1888, and Bull and Milner, 1925; for the interpretation see Hollingworth and others, ref. 20, p. 33).

My opinion is that most of the exotic blocks of the Kiogar-Chirchun district, in so far as they are included in the local Cretaceous sediments, are landslips in a very special sense, landslips that have slipped up and out from below the buried bottom of the advancing thrust-mass, rather than down and out from its uncovered front.

## Conclusion

A Tibetan thrust-mass invaded a Himalayan stretch of Tethys sea bottom, already occupied by submarine volcanoes. Driven underground, these volcanoes maintained a guerrilla attack by injection of molten material from below. Wear and tear due to withdrawal of overrun, overloaded mobile sediments added to the general confusion.


[1] Schardt, H., *C.R. Acad. Sci., Paris*, **117**, 707 (1893); *Arch. Sci. Phys. et Nat., Genève*, 3rd ser., **30**, 570 (1893).
[2] Griesbach, C. L., *Rec. Geol. Surv. India*, **26**, 19 (1893).
[3] Krafft, A. von, *Mem. Geol. Surv. India*, **32**, 127 (1902).
[4] Diener, C., *Mem. Geol. Surv. India*, **36**, 132 (1912).
[5] Griesbach, C. L., *Rec. Geol. Surv. India*, **26**, 25, which carries an editorial note that "Mr. Middlemiss does not accept this explanation" (1893).
[6] Griesbach, C. L., *Compte Rendu IX Sess. Con. Géol. Internat.* (Vienna, 1903), **2**, 550 (1904).
[7] Diener, C., *Mem. Geol. Surv. India*, **28**, 21 (1898).
[8] Diener, C., *Mem. Geol. Surv. India*, **36**, 139, 140 (1912).
[9] Suess, E., *C.R. Acad. Sci., Paris*, **139**, 714 (1904).
[10] Bailey, E. B., *Bull. Geol. Soc. Amer.*, **47**, 1722 (1936).
[11] Heim, Arnold, and Gansser, A., *Mém. Soc. Helvétique Sci. Nat.*, **73**, 174, 184 (1939).
[12] Griesbach, C. L., *Mem. Geol. Surv. India*, **23**, 83, 84, 130, 155 (1891).
[13] Lydekker, R., *Mem. Geol. Surv. India*, **22**, 111 (1883).
[14] Wadia, D. N., *Rec. Geol. Surv. India*, **68**, 419 (1935).
[15] Lydekker, R., *Mem. Geol. Surv. India*, **22**, 116 (1883).
[16] Bailey, E. B., *Geol. Mag.*, **81**, 99 (1944).
[17] Bailey, E. B., "Tertiary and Post-Tertiary Geology of Mull, Loch Aline and Oban", *Mem. Geol. Surv.*, 120 (1924).
[18] Reid, C., and Dewey, H., *Quart. J. Geol. Soc.*, **64**, 267 (1908).
[19] Suess, E., "La face de la terre", **3**, 1497–1505 (de Margerie Ed., Paris, 1918).
[20] Hollingworth, S. E., Taylor, J. H., and Kellaway, G. A., *Quart. J. Geol. Soc.*, **100**, 1 (1944).


# SCIENTIFIC COLLABORATION BETWEEN INDIA AND BRITAIN

A COUPLE of months ago, a delegation consisting of six of India's leading scientific men arrived in Great Britain to study the organization of scientific research and of industrial research and development. The party consisted of Dr. Nazir Ahmad, director of the Cotton Technological Laboratory, Matunga, Bombay; Sir Shanti S. Bhatnagar, director of scientific and industrial research, India; Sir Jnan Chandra Ghosh, director of the Indian Institute of Science, Bangalore, and president of the National Institute of Sciences of India; Prof. S. K. Mitra, Calcutta, chairman of the Radio Committee of the Board of Scientific and Industrial Research; Prof. J. N. Mukherjee, professor of chemistry, University College of Science and Technology, Calcutta; and Prof. Meghnad Saha, of the University College of Science and Technology, Calcutta. The visit came to an end on December 1, when they left for a similar tour in Canada and the United States. On the previous day, at a farewell luncheon in London, Prof. Mitra summed up, on behalf of the mission, the impressions which they had received. He said:

"It is just over seven weeks since we arrived in Great Britain. Our visit to this country as guests of His Majesty's Government will presently be coming to a close. During our stay here we have received nothing but kindness, courtesy and, from all concerned, the desire to meet our slightest wishes. I take this opportunity of thanking most sincerely on behalf of my colleagues, His Majesty's Government, the Royal Society, the India Office and the Office of the High Commissioner for India for the trouble and care they have taken to make our visit as profitable as possible.

"On the eve of our departure, we are being asked by our friends about our impression of war-time England. To this we say that we have been greatly impressed by the wonderful spirit of team-work of the people, by the way in which the human power and the material resources of the country have been mobilized to fight the enemy and by the steadfastness of your will to win. In particular, in the matter of organizing scientific research, in which we were specially interested, we were struck by the manner in which scientific talent throughout the country has been mobilized and researches in the different branches of science co-ordinated to produce the most fruitful result in the quickest possible time. We were also delighted to see that the industries directly responsible for the huge war productions have realized the importance of scientific research. We felt that without this collaboration between science and industry on one hand and the Government on the other, the successful prosecution of the War would have been an impossibility. We are sure that this new spirit of collaboration for the common cause will continue after the War and find its way to our country for constructive work.

"We are also being asked if our mission in Great Britain has been a success. Has it been worth the time and trouble that His Majesty's Government has spent on this visit of ours? To this we gratefully reply that we have seen and learnt whatever we wanted to see or learn. We have made contacts with the most distinguished men of science, industrialists and social workers of the country. Further, what to us has been of the utmost importance, we have had the fullest opportunity of studying the method of organizing scientific research for national needs to which I referred just now. We have visited many large-scale industries and have been taken round the most complicated manufacturing processes by the directors of the industries themselves. To us this has been a kind of a revelation. We now understand how much technical talent, large-scale organization and sense of team-work are necessary for efficient running of such industries. We hope to enlighten our countrymen on these matters when we return to India.

"One of our colleagues very aptly remarked that for the last seven weeks we were being put through an intensive course of adult education. So far as this aspect of the visit is concerned, we think it has been a success, because we hope we have not proved ourselves to be students who shirk work. Our object in coming to Britain, however, was not only to educate ourselves, but also at the same time to acquaint the people of Britain, by free and frank discussion and exchange of views, with our problems and needs. If by our visit we have, even in a small measure, been able to achieve this, we shall consider that our mission has been a complete success.

"The discoveries and inventions of science have annihilated space and time. We can now flash across space news which will go round the earth seven times in one second. We can cover distances in hours which formerly would have taken days. The world has in effect grown smaller. A result of this has been that the different nations of the world are being brought into closer and more intimate contact. In future, the different nations, big or small, will have to march together, whether they will or not. But this marching together will only be a source of strife and conflict if the different nations do not keep pace with each other. Nations which for some reason or other are left behind will be a drag on those moving forward and, by causing friction, will act as a brake on general progress. It is therefore the duty of the advanced nations, in their own interest, to see that none may be lagging behind, and to lend a helping hand to those who may unfortunately be so.

"I believe that it is the duty of every nation to strive for progress, as it is the endeavour of the plant to seek light. India has for a long time failed in this duty. It is no use discussing who has been responsible for this inaction. India is now striving for progress, and we are sure you will be ready to help us in our endeavour to seek light and freedom—freedom from want.

"In conclusion, I would thank, on behalf of my colleagues, all those who for the past seven weeks have been responsible for arranging our programmes, planning our visits and, in a hundred other ways, doing all that was necessary to make our visit as useful and as pleasant as possible. It is difficult to express adequately our gratitude to them for all they have done for us. The memory of this very pleasant visit, which has forged as it were a link of goodwill and fellowship between the scientific workers of your country and ours, will always be cherished by us. We shall be leaving the shores of Great Britain in the confident hope that India, just as she has been a partner of Great Britain in her struggles and tribulations in the dark days of war, will also be a partner of her prosperity in the days of peace in the near future."

---

# OBITUARY

## Sir Arthur Eddington, O.M., F.R.S.

THE death on November 22, at the age of sixty-one, of Sir Arthur Stanley Eddington is a great loss to science. In these days of specialization in science, it is given to few to have so wide a range of interests and to make contributions of outstanding merit in such diverse fields as he did. He combined to a unique degree an appreciation of the significance of new developments with great powers of mathematical analysis and keen physical intuition. A gifted expositor of the newest trends in physics, he was able to describe the most abstruse theories in clear and simple language; his name and writings were known throughout the world.

Eddington was born on December 28, 1882, at Kendal, Westmorland, of a Quaker family, his father being the headmaster of the Friends' School at Kendal. In 1902 he entered Trinity College, Cambridge, after having carried all before him at Owens College, Manchester. In the Mathematical Tripos of 1904 he was Senior Wrangler and in the following year was placed in the first division of the first class of Part II of the Tripos. In 1907 he was Smith's Prizeman and was elected to a fellowship at Trinity College.

In 1906 Eddington was selected by Sir William Christie, the Astronomer Royal, to fill the vacancy in the post of chief assistant at the Royal Observatory, Greenwich, caused by the appointment of F. W. Dyson as Astronomer Royal for Scotland. At Greenwich, he obtained experience in observational astronomy and a familiarity with its problems which were to stand him in good stead. Though his interests were primarily in theoretical investigations, he was able to appraise the value of observations and to test theoretical conclusions by means of the data

provided by observation. He discussed the observations made with the Airy reflex zenith tube and when, as the result of this discussion, it was decided to discontinue these observations and to employ the Cookson floating zenith telescope, loaned by the Cambridge Observatory, for the determination of the variation of latitude and of the constant of aberration, he planned the programme of observation with this instrument.

But Eddington's main interest at this time was in stellar motions. Kapteyn had but recently announced his discovery of the two star-streams. A rapid increase in knowledge of the proper-motions and radial velocities of the stars was taking place. Eddington used the new material, discussed it thoroughly, and confirmed and amplified Kapteyn's conclusions. In 1914 his "Stellar Motions and the Structure of the Universe" was published. This work contained an account of his own researches, but this was made subservient to the wider aim of giving an account of the many recent discoveries in sidereal astronomy and co-ordinating them to present, so far as was possible at the time, a coherent description of the stellar universe. In each of the main fields in which Eddington worked, he followed the same plan of publishing a connected account of the new advances, incorporating the work of others; students and investigators of these fields are greatly indebted to him for the valuable assistance which was thus provided for them.

In 1913 he was elected to the Plumian professorship of astronomy at Cambridge, which had become vacant through the death of Sir George Darwin; and the next year, after the death of Sir Robert Ball, he was appointed director of the Cambridge Observatory. In 1916 he took up the study of the radiative equilibrium of the stars. Schwarzschild had developed in 1906 the theory of the radiative equilibrium of a star's atmosphere, but did not apply the theory to the interior of a star. Eddington found that the extension of the formulæ to the interior of a star was not difficult. The theory was thought at first to be applicable only to the diffuse giant stars; it was considered that in the interiors of the dwarf stars, with their much greater mean densities, there would be an appreciable departure from perfect gas laws. The theory indicated that the bolometric magnitude of a gaseous star is independent of its stage of evolution and depends only on its mass. But in 1924, as the outcome of a careful discussion of all the reliable determinations of stellar masses, he found that the formulæ of the theory predicted correctly the absolute magnitudes of all ordinary stars, regardless of whether they were giants or dwarfs.

This discovery of the correlation between the masses and the luminosities of the stars was a result of outstanding importance. It showed that dense stars, such as the sun, obeyed the laws of a perfect gas; it also necessitated a complete revision of the then accepted views of stellar evolution. The two branches of the familiar Russell-Hertzsprung diagram must either represent loci of equilibrium points or, if there was evolution along them, it must be accompanied by appreciable loss of mass. The white-dwarf stars did not satisfy the mass-luminosity relationship; Eddington came to the revolutionary conclusion that the mean density of 53,000 of the companion of Sirius was not absurd and should be accepted; he pointed out that, if this density were correct, there should be an Einstein shift of its spectral lines of about 20 km. per sec., which was shortly afterwards confirmed by Adams at Mount Wilson. Eddington also investigated the problem of the Cepheid variable stars, on the hypothesis that their light variations were caused by periodic pulsations, and was able to account for the period-luminosity relationship obeyed by these stars, which had been found by Miss Leavitt at Harvard from the study of Cepheid variables in the Magellanic Clouds. In 1926 Eddington gave a connected account of these investigations in "The Internal Constitution of the Stars", while "Stars and Atoms" (1927) gave a fascinating and graphic description of the new results in a form intelligible to the general reader.

In 1926 Eddington gave the Bakerian Lecture of the Royal Society, taking as his subject "Diffuse Matter in Interstellar Space"; this was an important contribution to the understanding of the nature of the interstellar clouds. He found that ionization and capture form the main process of interchange between radiant energy and atomic kinetic energy in diffuse gas, and that this tended to raise the temperature to the level of the effective temperatures of stars, independently of the dilution of radiation. He modified the usual equilibrium formulæ for the amount of ionization to apply to matter in a field of evenly diluted radiation. The relative abundance of sodium to calcium was found to be very much greater than on the earth; the tremendous preponderance of hydrogen over all other elements was not realized at that time, and Struve later showed that the discordance was much reduced when it was assumed that hydrogen supplied the overwhelming majority of the free electrons. Eddington concluded that the stationary sodium and calcium lines in the spectra of early-type stars were produced by absorption by the interstellar cloud; but found that the dimming of distant stars by interstellar gas could not be accounted for unless it was assumed that these contained non-gaseous (meteoric) matter. This conclusion has since been amply confirmed.

Concurrently with these investigations, Eddington had also been occupied with the theory of generalized relativity. The War of 1914–18 had disrupted scientific intercourse, and Einstein's important papers were generally unknown in Great Britain. Eddington had received a copy from the Dutch astronomer, de Sitter, in 1917; he immediately accepted the new theory, perceiving its great importance. His "Report on the Relativity Theory of Gravitation", prepared for the Physical Society in 1918, provided the first account of the new theory in the English language and did valuable service in bringing the theory to the notice of British men of science. Many were converted to it; but many others, because of its revolutionary conceptions and the employment in its mathematical development of the tensor calculus, with which physicists and applied mathematicians were not generally familiar, were inclined to suspend judgment. The theory had accounted for the unexplained motion of the perihelion of Mercury, but further observational confirmation was needed to convince the sceptics. Sir Frank Dyson found that the total eclipse of the sun on May 29, 1919, would provide a particularly favourable opportunity for testing Einstein's prediction of the amount of the deflexion of rays of light by the sun. It was decided to proceed with the necessary preparations at Greenwich for two expeditions, to Brazil and the Island of Principe, though the state of the War at the time gave little hope that it would be possible for the

expeditions to set out. But the end of the War came in time, and Davidson and Crommelin from Greenwich went to Brazil, while Eddington and Cottingham went to Principe. Both expeditions made successful observations, and the results obtained supported Einstein's prediction of the amount of the deflexion, and did much to secure general acceptance of the theory. In "Space, Time and Gravitation" (1920) Eddington gave a non-mathematical account of the theory, to which he prefixed the very appropriate quotation from "Paradise Lost":

> Perhaps to move
> His laughter at their quaint opinions wide
> Hereafter, when they come to model heaven
> And calculate the stars: how they will wield
> The mighty frame: how build, unbuild, contrive
> To save appearance.

About this time there appeared a spate of popular accounts of the theory, but none could compare with Eddington's masterly presentation. In 1923 he followed this with "The Mathematical Theory of Relativity", which included an account of his own important contribution—a generalization of Weyl's theory of the electromagnetic and gravitational fields, based on the notion of parallel displacement. He emphasized that there must be woven into the structure of the world a standard of length making possible the comparison of lengths at different points in space-time.

Much of Eddington's later work was concerned with the development of the cosmological aspects of relativity theory and with the unification of quantum theory and relativity theory. Observations had shown that the external galaxies were receding from our own galaxy and from each other with speeds proportional to their mutual distances apart. This gave rise to the conception of the expansion of the universe. The small popular book "The Expanding Universe" (1933) gave an account of the phenomena to be expected in a finite expanding spherical universe, of the type first suggested by Einstein and later developed by the Abbé Lemaître. Eddington sought to find relations between the radius of curvature of space, the recession-velocity constant of the external galaxies, the number of particles (or the mean density of matter) in the universe and the physical constants, such as the ratio of the mass of the proton to that of the electron, the ratio of the gravitational to the electric force between a proton and an electron, the fine-structure constant and the velocity of light. The connexion between the constant of gravitation and Planck's constant was obtained by treating an Einstein universe first by relativity theory and then by wave-mechanics applied to the system of particles forming that universe. The mathematical account of the theory was given in "The Relativity Theory of Protons and Electrons" (1936) and was revised and completed in his lectures before the Dublin Institute for Advanced Studies, entitled "The Combination of Relativity Theory and Quantum Theory" (1943). These researches, to which Eddington gave much time and thought, have not yet carried general conviction, though the agreement between observed constants and the values found by pure reasoning are extraordinarily close. The extremely abstruse and complex nature of the investigations, which few can claim to have thoroughly understood, is no doubt responsible in some measure, but the purely deductive nature of the theory is an important contributory factor. Eddington wrote that:

"An intelligence, unacquainted with our universe, but acquainted with the system of thought by which the human mind interprets to itself the content of its sensory experience, should be able to attain all the knowledge of physics that we have attained by experiment. He would not deduce the particular events and objects of our experience, but he would deduce the generalizations we have based on them. For example, he would infer the existence and properties of radium, but not the dimensions of the Earth".

This is a philosophy of science that does not command general acceptance to-day. Nevertheless, it may well be that generations yet to come will regard Eddington's recent work as one of the most important and significant advances in science.

In "The Nature of the Physical World" (1928), being the Gifford Lectures for 1927, and "New Pathways in Science" (1935), being the Messenger Lectures at Cornell for 1934, Eddington dealt with the new developments in science—the theory of relativity, quantum theory, the principle of indeterminacy, the expansion of the universe, etc.—and with their effect on philosophical thought. Both books were essentially concerned with the question: What kind of knowledge does science give us? He showed that in dealing with the universe, science is confined to investigating its structure; it can tell us nothing of the nature of that which possesses that structure. It was not so much the particular form that scientific theories have now taken that is important, for they may in time give way to some fuller realization of the world, as the movement of thought behind them changes. Whatever changes may come, it will never be possible to go back to the old outlook. Eddington was a master of the English language, and these lucid expositions did more than any other books to make the intelligent layman aware of the new trends in science and of their philosophical implications.

Eddington was elected a fellow of the Royal Society in 1914 and was awarded its Royal Medal in 1928. He was president of the Royal Astronomical Society during 1921–23, and foreign secretary from 1933, and was awarded its Gold Medal in 1924. He was awarded the Bruce Gold Medal of the Astronomical Society of the Pacific in 1924. He was president of the Physical Society during 1930–32. He received honorary doctorates from twelve universities, and was honorary member, foreign member or foreign associate of many learned societies in Europe and America. He was created a Knight Bachelor in 1930 and received the Order of Merit in 1938. He was elected president of the International Astronomical Union at its last General Assembly in 1938. He was a great ambassador of science, who travelled and lectured widely.

Many in Great Britain mourn the passing of a friend and colleague while still in the zenith of his intellectual powers; their sense of loss will be shared by many others in all parts of the world, who have admired from afar his achievements and have received instruction and stimulus from his writings.

H. SPENCER JONES.

---

THROUGHOUT his career as an astronomer, Sir Arthur Eddington's connexion with the Royal Astronomical Society, both formal and scientific, was close and intimate. He was elected a fellow in 1906, was president during 1921–23 (a period of office which included the celebration of the centenary of the Society), received its Gold Medal in 1924, and

after H. H. Turner's death eventually inherited his office as foreign secretary, his corner-seat in the front row at meetings and, it is fair to add, his place in the affections of the fellows. He used its *Monthly Notices* as the medium of publication for almost all his fundamental contributions to science. Thus his early papers on star-streaming appeared there; his initial papers on Cepheid pulsations in 1916 appeared there; and these led in turn to his beautiful theory of the radiative equilibrium of the stars, in which the flow of radiation was first recognized as a basic process in the transfer of energy in stellar interiors, and in which the mechanical pressure of radiation was first shown to be an important element in the mechanical equilibrium.

The steps by which Eddington successively uncovered the dependence of relative radiation pressure on molecular weight, the dependence of that on ionization, the importance of radiation pressure in perhaps fixing the order of magnitude of the masses of the stars, and the probable gaseous character (on his hypotheses) of the whole interior of a star, are among the most fascinating in the history of mathematical physics. They led in turn to his recognition of the mass-luminosity law obeyed indifferently by giant and dwarf stars, which, however unsatisfactory still in its theoretical aspects, is an important supplement to our methods of ascertaining stellar masses. These steps accomplished, he returned to the question of the *chemical* constitution of stellar interiors, concluding (with others) that they are mostly hydrogen; and he completed in various ways his theory of pulsating stars. Further, he was a pioneer in the study of diffuse matter in interstellar space.

Eddington was ever a fighter for his ideas, allowing of no compromise when he had considered a matter and properly made up his mind. Many astronomers still remember titanic debates at the Royal Astronomical Society in which Eddington was protagonist and supreme defender of his own views; he asked no quarter, and he gave none. I think that a time may come when some of Eddington's more provocative conclusions on stellar structure may have to be re-valued, and that Eddington sometimes closed his eyes to the possibility of alternative attitudes to some of the scientific questions of the day. But as one who, in spite of wrestling with Eddington in public and in private in scientific disagreement, maintained always the happiest and friendliest personal relations, I join with heart-aching sincerity in the universal grief among the astronomical fraternity for one taken from us so unexpectedly, for a leader whose writings have been such an inspiration to lovers of astronomy and astrophysics, and for a dear friend to, and encourager of, all that was gentle, and wise, and witty, and satisfying in the sciences of which he was the devoted servant. Truly he was a great man.

E. A. MILNE.

---

ALL physicists deplore in the death of Sir Arthur Eddington the passing of a great leader in their science, whose genius they acknowledge as freely as they admit, in many cases, their inability to follow him in his most daring and difficult advances. These particular advances, however, form only part of his life's work: certain of his most striking achievements are based upon bold and penetrating applications of simple physical conceptions to problems not contemplated when they were elaborated. Nuclei stripped of all their electrons—of their crinoline, as Sir Alfred Ewing termed it—are a simple corollary of the nuclear theory of the atom: the pressure of radiation, measured in the laboratory, had been invoked to explain the behaviour of the tails of comets. Eddington seized upon these conceptions and, combining them with the laws of gravitation, evolved a theory within the comprehension of the ordinary physicist, which explained beautifully the general features of stellar structure and stellar evolution. Bare nuclei, together with the electrons freed from their normal orbits, readily represent a gas of great density, such as was required to explain the compactness of the dark companion of Sirius and other white dwarfs. By bold imaginative conceptions of this kind, combined with technical mathematical powers of the highest order, Eddington made of the stellar universe a physics laboratory where somewhat extreme conditions prevailed, but nevertheless a physics laboratory.

His early work on relativity and his observations that established the bending of light in a gravitational field were likewise matters which appealed to every physicist. His later work on the connexion of the theories of relativity and quantum mechanics, which enabled him to relate the velocity-distance relation of the spiral nebulæ to the number of elementary particles in the universe, and his mysterious number 137, are hard matters for many of us, but we feel that it is impertinence to criticize that which we do not understand, when it comes from a master. Here are great attempts at the solution of great problems, made in a manner that commands respect and admiration.

Eddington was a man of extremely wide interests in physics. In 1920 he wrote for the Physical Society a report on the Relativity Theory of Gravitation, which met an urgent need, and he was president of the Physical Society during 1930–32. He took a very active interest in the doings of the Society, and his presidential address on "The Expanding Universe" will be long remembered. When in the chair he showed a surprising familiarity with almost every aspect of physics that came before the meeting.

Eddington's more popular works, such as "Stars and Atoms", had a wide appeal to all interested in physical science. Physicists rejoiced to see the esoteric delights of their subject exposed with such perception, daring and vivacity. The width of Eddington's reading was shown nowhere so clearly as in his quotations, always apposite, which were drawn from an astonishing variety of authors. To the book just cited is prefixed a most apt citation from the Swiss anatomist and physiologist Albrecht von Haller, whose poetical works cannot be familiar to most English men of science,

> "Ich häufe ungeheure Zahlen,
> Gebürge Millionen auf,
> Ich setze Zeit auf Zeit und Welt auf Welt zu Hauf",

and elsewhere Descartes, Lucretius, Omar Khayyam, H. G. Wells, Isaac Newton, Cardinal Newman, Lewis Carroll, Milton, Shakespeare and the Bible among others are called upon.

It can be seldom, if ever, that one who was a master of the most abstruse technicalities of scientific thought could have been able to express himself as lucidly, as charmingly and as individually as Eddington does in his more popular works. He had in him something of the prophet, but one with a very much more amiable and conciliatory style in his writings than that of most prophets. E. N. DA C. ANDRADE.

# NEWS and VIEWS

## Sir D'Arcy W. Thompson, C.B., F.R.S.: A Professorial Record

"You will never live to my age, without you keep yourselves in breath with exercise, and in heart with joyfulness"—and so successfully has Sir D'Arcy Thompson fulfilled the injunction of Sir Philip Sidney that ere Christmas Day he will have completed sixty years as professor of natural history. On December 22, 1884, at the age of twenty-four, he was elected, as its first incumbent, to the chair of natural history in the newly opened University College of Dundee. Here, as at Edinburgh Academy, he was fortunate in his environment of good companions: his unsuccessful competitors for the chair included J. T. Cunningham, W. E. Hoyle and Patrick Geddes; his new colleagues in due course numbered among them as young professors who later gained wide recognition, Sir Patrick Geddes, who had accepted the chair of botany, Sir Alfred Ewing, principal and vice-chancellor of the University of Edinburgh, Sir William McCormick, secretary to the Carnegie Trust for the Universities of Scotland, Sir James Walker, professor of chemistry in the University of Edinburgh, and Sir William Peterson, principal of McGill University, Montreal. In 1897, University College, Dundee, which had begun as an independent institution, became an integral part of the University of St. Andrews, and in 1917, on the retiral of Prof. W. C. McIntosh from the chair of natural history in St. Andrews, which he had occupied since 1882, it was a fitting and natural move that D'Arcy Thompson should be transferred to the senior chair. His predecessor retired in his seventy-ninth year; in his eighty-fourth Sir D'Arcy continues to teach with vigour and to take part in many activities outside the University.

In his early years in Dundee, Sir D'Arcy Thompson, like many another, was drawn to the marine invertebrates, particularly to the Cœlenterates and Bryozoa, and began the building up of a collection which eventually contained an unusual number of authenticated representatives of invertebrate species. But his interests were wide, and his appointment as a delegate to the Behring Sea Fisheries Conference in 1897 and his selection in the following year to be scientific member of the Fishery Board for Scotland gave public recognition to what has remained a main aspect of his scientific work. For forty years, that is until the Fishery Board was disbanded recently, he retained its scientific membership and guided the development of its scientific investigations; and his own published papers on the statistics of fisheries and the distributional occurrence of rare species of fishes show his personal predilection. This was but one of many interests—the classics and the natural history of the ancients, the perfection of adaptation in many creatures, the influence of physical law in moulding the parts of animals, growth and form; but perhaps the fundamental and rejuvenating interest throughout has been the outlook of the born naturalist, which finds its satisfaction by the shores of the North Sea or in the woods of the Spey valley.

## Conway Evans Prize: Sir Thomas Lewis, C.B.E., F.R.S.

The presidents of the Royal Society and of the Royal College of Physicians have awarded the Conway Evans Prize to Sir Thomas Lewis, in recognition of his great contribution to medical knowledge on the normal and abnormal mechanisms of the heart and circulation of the blood. This prize, in accordance with the will of the late Dr. Conway Evans, who was medical officer for the Strand District, is awarded from time to time for scientific work of outstanding distinction. It was first given to Sir Charles Sherrington in 1927 and since then to the late Dr. John S. Haldane in 1933, and to Sir Frederick Gowland Hopkins in 1938. It will be seen that so far the prizes have been awarded infrequently with the intention that they should be given only in recognition of outstanding contributions to science, thus fulfilling the intention of the donor. Sir Thomas Lewis has worked essentially in a field which he has called 'clinical science', and he has clearly indicated how the modern developments of science in general can be applied to the many problems of medicine at the bedside.

## An International Office for Education

Dr. Harlow Shapley, speaking on behalf of the U.S. Office of War Information, recently broadcast an address in the United States with reference to an International Office for Education. He pointed out that both education and lack of education play a part in our present world-wide troubles. The high technical training in the armed forces, and also in the war factories that back the armies and navies, represents a type of education that is indispensable in our effort to bring back peace and social sanity to the world. But it is a lack of education—a deficiency in elementary social education, or a perversion of it, that has brought the madness of totalitarian war upon us. In too many parts of the world the fundamental education has not been planned so as to teach us how to live and let others live intelligently in the kind of world that modern technical civilization has given us. In the social evolution that is necessary for a good and progressive world society, we must have a basic education so widespread, and so democratic in spirit, that demagogues cannot easily lead us into inhuman and selfish and false creeds. We must have, if possible, in all grades of our educational systems, the desire and freedom to question statements, to challenge dogmas. We must question our teachers, and not be blindly led by them. We should encourage internationalism in our leaders. We must have, especially in our elementary schools, a universal recognition that there are international allegiances as well as national responsibilities, that we are a part of a world-wide human society.

It is to facilitate the reform or the improvement of educational systems in all countries that the setting up at the earliest time practicable of an International Office for Education is suggested. Such an office is not intended to be a temporary affair, concerned with rehabilitation problems. Such reconstruction work is necessary and immediately urgent. Steps toward carrying it through are well under way. But of necessity, rehabilitation is a re-establishment of the conditions that existed before the blight of war passed over the land. Rehabilitation is in a sense backward-looking, rather than forward-look and evolutionary. The advocated International

Office for Education should be set up for all time, and be oriented toward the future, toward a socially improving future. Particular educational systems in any country are not suggested. Rather, the International Office should act as a clearing-house for educational ideas, an information centre for the educators and for the educational bureaux and ministries that need guidance and specific assistance in the improving of their work. In the specialized sciences and arts there have long been useful international unions. In their limited fields such organizations have shown how relatively simple it is for the people of all nations to co-operate. What has been done in the sciences can certainly be done in the general educational field. The great usefulness of the International Labour Office during the past two decades shows how important, for international understanding, an organization of this sort can be. That the establishment of an International Office of Education appeals to Americans of all sorts has been indicated by the rapid support received from scores of important organizations—from church, labour, industry and education—and from numerous members of the National Congress. It is hoped that the American Government will join with the other free governments of the world, in an official recognition of the essential part of education in the planning for a better and more peaceful world.

## Visual Aids in the Schoolroom

THE remarkably comprehensive and suggestive paper recently read at the Royal Society of Arts by Mr. R. W. Moore, headmaster of Harrow, calls for special comment. The progressive teacher, he said, is alive to the uses of the epidiascope, and films have established themselves as an important subsidiary in schools. In the past, visual factors have been neglected, no doubt. Yet, he said, we must ask ourselves whether worse dangers than those of neglect are not involved in the uncritical multiplication of visual aids now prevalent in some quarters. Illustration is confused with explanation. Excess of detail, leading to distraction and irrelevance, abounds. True, the development of new processes promises a great enrichment for teacher and pupil; but our chief need is that of a psychology of education which will take account of these visual adjuncts and order them. The subjects which most need visual aids, said Mr. Moore, are science, history and geography. Of the three, he proceeded, science is the best case, because observation has long since been recognized as basic in the scientific tradition, and also scientific men have a professional bias towards, and a mechanical dexterity in, the manipulation of visual aids. History is the most difficult to accommodate to such aids. Geography stands between. It is the study of man in his natural environment. As a subject, it has only recently emancipated itself from the verbalism of the academic tradition. It should have its roots in observation and begin with local investigation. But how are we to extend the process towards a knowledge of world geography? How is the child in a poor London school to observe India and South America? Films are here intensely valuable, but the material available is sadly thin. The present needs are: (1) that research and experiment be made inside the teaching profession towards ascertaining what visual aids are appropriate to particular subjects and purposes, and (2) that there should be thorough co-operation between teachers and manufacturers before and during production.

## A Natural Elastic Polyester

SOME of the newest and most fascinating developments in applied science lie in the field of high polymers—and yet the story of high polymers, since they form the principal physico-chemical basis of life, is one of the oldest and most fundamental in the world. Most natural chain-molecules still cannot be synthesized by man; but he can build many others that are not found in Nature. Among the latter were thought to be the polyesters, first synthesized by Carothers and Arvin in 1929. It is reported now by A. R. Kemp and H. Peters (*India Rubber World*, 110, 639; 1944) that what seems to be very likely a polyester constitutes the highly elastic skin that fits tightly round the seeds of *Smilax rotundifolia* Linn. The ripe berries usually contain three seeds about $\frac{1}{2}$ cm. in diameter, each enclosed in a membrane about 0·003 cm. thick. On removal, the membrane is found to be stretchable by 300–400 per cent and to give then a typical X-ray fibre photograph with a probable fibre period of about $22\frac{1}{2}$ A. This finding, taken in conjunction with chemical analyses carried out on the skins both before and after hydrolysis with alcoholic caustic potash, indicates that the main component is a polyester formed by the repeated condensation of a unit having 17 or 18 carbon atoms in the chain with two hydroxyl side groups, the suggested empirical formula of the monomer being $C_{18}H_{36}O_5$. The conclusions are for the present tentative, but they are by no means unconvincing, and the results of further investigation—very much worth while—will be awaited with interest.

## Earthquake in Japan

ONE of the most violent earthquakes of recent years was recorded by the seismographs at Kew, West Bromwich, New York and Bombay, and probably throughout the world, on December 7. At West Bromwich it was recorded at 4h. 48m. 38s. G.M.T., and the waves were so violent that the recording mechanism was upset. At Fordham, New York, the Rev. J. J. Lynch believes from a preliminary investigation of his records that two shocks were recorded, at 12.49 and 12.53 a.m. (local time). The Japanese News Agency stated that the Island of Honshu was affected, and that it was believed that the epicentre was in the Sea of Nshu. The Tokaido district was affected and also Shizuoka, Hamamatsu, Nagano and Nagoya, the third largest city of Japan. There was some damage to property and a seismic sea-wave affected Shizuoka. It appears unlikely that further details will be obtainable from Japan until the end of the War; but this was undoubtedly a very great earthquake, and when the records are examined closely the epicentre will be found more precisely.

## The Phosphorus Cycle in Nature

FOR his presidential address to the Geological Section of the Congress of the South Eastern Union of Scientific Societies, held on October 14, Dr. K. P. Oakley took as his subject "Man and the Migrations of Phosphorus". For some time after the earth's formation, the phosphorus cycle in the sea was simple, the phosphate ions being built up into the earliest forms of organic life and released again at their death, the only loss occurring through the precipitation of phosphate ions accumulated at the lower levels, with the formation of sedimentary rock phosphate beds. Following the emergence of life from the sea and the

*The vacancies advertised in these columns are available only to applicants to whom the Employment of Women (Control of Engagement) Orders, 1942-3, do not apply.*

## The Royal Institute of Chemistry of Great Britain & Ireland

(Founded 1877)
(Incorporated by Royal Charter, 1885)

### APPOINTMENTS REGISTER

A Register of Chemists (Fellows, Associates and Senior Registered Students), who are available for appointments or who are seeking to improve their positions, is kept at the office of the Institute. The facilities afforded by this Register are available (free) to Companies and Firms requiring the services of chemists, and to Universities, Colleges and Technical Schools requiring Teachers of Chemistry and Technology.

Particulars of the Regulations and Examinations of the Institute can be obtained (free), on application to The Registrar, the Royal Institute of Chemistry, 30 Russell Square, London, W.C.1.

### COURSE IN COLLOID SCIENCE AT CAMBRIDGE

The Committee of the Birmingham and Midlands Section of the Royal Institute of Chemistry, in co-operation with the Departments of Colloid Science and Physical Chemistry in the University of Cambridge, has arranged for a post-graduate course in Colloid Science to be given in Cambridge from Saturday, June 23 to 30, 1945.

The Course is intended to assist Chemists, in industry and elsewhere, to improve their fundamental knowledge of Colloid Science, and to acquaint themselves with recent work.

Seventeen lectures will be given by members of the University Staff, and there will be a short practical course. Opportunities for scientific visits and social amenities will be provided. Tuition will be under the general supervision of Dr. A. E. Alexander, Fellow of Kings College.

The Fee for the Course will be nine guineas. This will include board and lodging, tuition, and practical work, and a printed copy of the lecture notes. Two guineas will be payable on acceptance, and the balance on June 1.

Application to join the Course should be made not later than Jan. 31 to E. M. Joiner, 15 Halton Road, Sutton Coldfield.

If the applications exceed the vacancies, preference will be given to Members of the Royal Institute of Chemistry.

### UNIVERSITY OF OXFORD

SIBTHORPIAN PROFESSORSHIP OF RURAL ECONOMY

Applications are invited for the above Professorship, and should reach the Registrar of the University not later than Feb. 24, 1945. Stipend £1,200 a year with an additional sum of £200 a year by way of special allowance in respect of duties as Head of the Department. Retiring age 65.

Further particulars may be obtained from the Registrar, University Registry, Oxford.

### UNIVERSITY OF CAMBRIDGE DEPARTMENT OF AGRICULTURE

The services of an experienced assistant are required by the Advisory Chemist. Applicants should possess suitable academic qualifications in chemistry or agricultural chemistry, and should have had experience of analytical work, and, if possible, field work with soils. The post is graded as a Temporary Senior Scientific Assistant, with a salary range of £275 to £375, and a war bonus is also payable.—Applications, together with not more than three recent testimonials, should be sent to the Secretary, School of Agriculture, Cambridge, not later than Dec. 30, 1944.

### UNIVERSITY OF BRISTOL

DEPARTMENT OF AGRICULTURE AND HORTICULTURE, LONG ASHTON

Applications are invited for the post of ASSISTANT to the ADVISER IN MYCOLOGY for the Western Province under the scheme of the Ministry of Agriculture and Fisheries. The appointment will be in the Temporary Senior Scientific Assistant grade, with minimum salary of £300 per annum, plus war bonus.

Further particulars may be obtained from the undersigned, to whom applications, together with copies of three recent testimonials, should be addressed not later than Dec. 28, 1944.

### UNIVERSITY OF BRISTOL

ENTRANCE SCHOLARSHIPS

The University will proceed to award Scholarships (value £100) for the Session 1945-6 for the Faculties of Arts, Science, Medicine, Engineering, and Law, after an examination to be held in the spring of 1945.—Details of the examination and application forms may be obtained from the Registrar, The University, Bristol, 8.

### DEPARTMENT OF SCIENTIFIC AND INDUSTRIAL RESEARCH)

NATIONAL PHYSICAL LABORATORY

An analytical chemist is required for the Metallurgy Division of the National Physical Laboratory. Candidates should preferably be 30-40 years of age and should have a 1st or 2nd class honours degree in Chemistry or Metallurgy or its equivalent, and wide experience in the analysis of metals and inorganic materials and in the use of physico-chemical methods. The duties will include development of methods for dealing with special problems. The initial salary contemplated will be £500 to £650 per annum, plus Civil Service War Bonus, but will be fixed according to age, qualifications and experience.

Applicants should write quoting F3304 A to the Ministry of Labour and National Service, Central (T. and S.) Register, Room 5/17, Sardinia Street, Kingsway, London, W.C.2, for the necessary forms, which should be returned completed on or before Dec. 27, 1944.

### BUSINESS OPPORTUNITY

Old-established Company of Scientific Instrument makers (London) are prepared to negotiate Sale 1/3rd interest. Purchaser to take position according to qualifications.—Write Box 60, Walker's Advertising Agency, 24, Coleman Street, London, E.C.2.

**Imperial Chemical Industries Limited** invite applications for the following posts at their Agricultural Research Station, Jealott's Hill, Bracknell, Berks: (1) Field Trial Officers.—Degree or Diploma in Agriculture either direct from College or with one or two years' technical agricultural experience in addition. Male. Age 21 to 25 years. Salaries according to experience and qualifications. (2) Recorder of Field Experiments.—University Degree or equivalent in Agriculture, either direct from a University or with one or two years' technical experience in addition. Male. Age 21 to 25 years. Salary according to experience and qualifications. (3) Machinery and Implement Assistant.—A man of 25 to 30 years of age having a sound knowledge of maintenance and repair of internal combustion engines and farm machinery. Salary according to experience and qualifications.—Applicants should apply to Central Staff Department, I.C.I. Ltd., Welwyn Garden City, Herts.

**Sudan Government.** Applications are invited for the post of INSPECTOR OF AGRICULTURE, on a short-term contract of five years. Candidates must have had a thorough practical training and experience in agriculture, and should preferably be holders of a University Degree in Agriculture. Tropical experience will also be useful. Age 35 to 45. Slight physical disability would not necessarily debar candidates. Commencing salary £E.800 to £E.1,000 per annum (£E.1=£1 0s. 6d.). Free passage on appointment. At the present time there is no Income Tax in the Sudan. Applicants should write, quoting F.3285A, to the Ministry of Labour and National Service, Central (T. & S.) Register, Room 5/17 Sardinia Street, Kingsway, London, W.C.2, for the necessary forms, which should be returned completed on or before Jan. 2, 1945.

**Radio Development Engineers required** for the Laboratory of large Electrical Engineering Works in the N.W.—B.Sc.(Hons.) Physics or Chemistry, or equivalent, standard—age 25 to 30. Salary according to age, qualifications and experience—from £375—£600 per annum.

Applicants should write quoting A.736 XA to the Ministry of Labour and National Service, Central Register, Room 5/17, Sardinia Street, Kingsway, London, W.C.2, for the necessary forms which should be returned completed on or before Jan. 11, 1945.

**Graduate Assistant Physicist is required** for the Research Department of the Fine Cotton Spinners' & Doublers' Association, Limited. Previous textile experience is not essential, but good mathematical standard with sound mechanical sense and interests are desirable. A knowledge of statistics, with some experience of photography and photomicrography would be additional advantages.—Applications, giving age, qualifications, industrial experience (if any), and salary required, with copies of testimonials, should be forwarded to the Director, Research Department, The Fine Cotton Spinners' & Doublers' Association, Rook Bank, Bollington, nr. Macclesfield.

**The British Drug Houses, Ltd., invite** applications for the position of Private Secretary to their Production Chief. Applicants must be first-class shorthand typists and have B.Sc. (chemistry, physics, or physiology) degree. Excellent salary will be paid to applicant with satisfactory qualifications.—Write, giving fullest particulars (age, experience, etc.), to Office Manager, The British Drug Houses Ltd., Graham Street, N.1.

**Analyst (Graduate or A.R.I.C.) urgently** required for Inorganic Analytical Development in Research Laboratories of scheduled Chemical and Metallurgical plant in Lancashire. Applicants should possess not less than 5 years' practical industrial analytical experience. Salary £400 to £500 per annum, according to ability and experience.—Replies, stating age, education, degrees, and experience, to Box 274, T. G. Scott & Son, Ltd., 9 Arundel Street, London, W.C.2.

**Wanted immediately Chemist,** not necessarily qualified, but with knowledge of Photography essential, to take charge of Photographic Laboratory near London. Permanent, progressive post-war appointment.—Box 272, T. G. Scott & Son, Ltd., 9 Arundel Street, London, W.C.2.

**Chemist, 34, good Cambridge degree** and postgraduate research experience, special knowledge nutrition, agric. science, dehydration of crops, horticulture, plant control, and administration; has travelled; languages; hard working; seeks worthwhile post; free now.—Box 276, T. G. Scott & Son, Ltd., 9 Arundel Street, London, W.C.2.

**Wanted: Qualified Timber Technologist** to prepare instruction papers on Forest Products.—Box 281, T. G. Scott & Son, Ltd., 9 Arundel Street, London, W.C.2.

**Quartz Microscope Lenses, etc., needed** urgently for biological research of national importance. Offers of quartz microscope slides (3 in. x 1 in.) and cover slips, quartz condenser, quartz lenses suitable for ultra-violet microscopy, will be most acceptable and should be addressed to Box 269, T. G. Scott & Son, Ltd., 9 Arundel Street, London, W.C.2, giving relevant details and price.

**Urgently required for Government** work; Pair Zeiss 30 mm. Front Attachment Lenses for Zeiss Pulfrich Photometer.—Reply to Box 280, T. G. Scott & Son, Ltd., 9 Arundel Street, London, W.C.2.

**Urgently required for high priority** Government work, 0-100 wattmeter.—H. Frost & Co., Ltd., Fieldgate, Walsall.

**Required by Doctor: Modern Leitz** Fluorite Objective, oil immersion, 1/7a or 1/10a, and Periplanatic ocular x 10.—Box 282, T. G. Scott & Son, Ltd., 9 Arundel Street, London, W.C.2.

**Polyglot Translation Service Ltd.,** 287 Terminal House, London, S.W.1. Telephone: SLOane 7059. Translations of every description from and into all languages.

PRINTED IN GREAT BRITAIN BY FISHER, KNIGHT AND CO., LTD., ST. ALBANS

colonization of dry land, a soil-plant-animal-soil cycle arose, from which phosphorus was removed in small quantities in the formation of bone beds, fossil fish or guano deposits. With the development of agriculture in historic times, however, the phosphorus cycle has been seriously upset, for systematic cropping reduces the reserves in the soil more quickly than they can be renewed from fresh sources. In the past few centuries man has attempted to restore the phosphorus balance by the use of fertilizers, derived largely from natural deposits; but he has also accelerated the transference of phosphorus from plant and animal life to the sea, thus speeding up its cyclical migration in a two-fold manner. Although this has been of undoubted benefit to man, it will ultimately lead to a state of bankruptcy with regard to the element. The world reserves of workable mineral phosphate are within measurable distance of exhaustion, and although new sources may be discovered, a planned economy in their utilization seems called for, as no substitute for phosphate exists and it is essential to the survival of a large human population. The address, which includes a historical account of phosphatic fertilizers, is to be published in the January issue of the *South Eastern Naturalist and Antiquary*.

## Mathematics in China

In addition to work directly for the war effort and in spite of difficulties of communication, mathematicians in China are able to produce a considerable amount of new work of the highest quality. In particular, we may mention Prof. L. K. Hua, of the Tsing Hua University in Kunming, whose visit to Cambridge during 1936–38 will be remembered. The following information has been received through the British Council Cultural Scientific Office at Chungking. Prof. Hua has just completed a booklet on additive prime number theory which will be published by the Academy of Sciences of the U.S.S.R. The first of a series of papers on the theory of automorphic functions of a matrix variable has just been published in the *American Journal of Mathematics*. Related to this is a theory of modular functions connected with linear associative algebras, which is so far unpublished. Another field in which Prof. Hua has been working is that of the geometry of matrices, related to topological algebra. In addition, Prof. Hua has continued his studies in the geometry of numbers and, in extending theories due to Minkowski and Dr. K. Mahler, has discovered a new type of convex body.

## Astronomical Observations in Spain

In the issue for 1944 of the *Boletín Astronómico Del Observatorio De Madrid*, E. Gullón supplies a résumé of the observations of solar prominences during September–December 1939. Owing to the removal of certain equipment from Valencia to Madrid and to other causes, observations could not commence before September 1. Sunspot observations during the same period were made by E. Gullón and Martín Lorón with the 20-cm. Grubb equatorial, and the results are shown on pages 14–16. Solar prominences during 1940 were observed by E. Gullón and the results are given in the same form as those observed during 1939. The last section of the bulletin deals with sunspot observations carried out by E. Gullón and Martín Lorón at Madrid and Valencia in 1940. Those at Madrid were made by means of a Herschel helioscope mounted on the 20-cm. Grubb equatorial, focal length 3 m., and those at Valencia were made with another equipment of a similar type on the 15-cm. Grubb, and with a focal length 2.20 m.

## Swedish-made Drugs

According to the August issue of the *Anglo-Swedish Review*, a new local anæsthetic has been discovered which in several respects far surpasses novocaine, which Sweden had hitherto to import. This new anæsthetic has been named *LL* 30, the letters standing for the names of two young scientific workers Lövgren and Lundquist, and the figure representing the number of anæsthetic compounds tried and discarded during their six years of investigation. *LL* 30 is now being made on a commercial scale by the Astra concern of Södertälje not far from Stockholm, where penicillin is also being manufactured. Sulphonamide preparations are being manufactured from Swedish raw materials, and its price is now down to half that of the imported foreign preparations.

## Books on Historical Medicine and Science

The annotated catalogue issued by Schuman's, 30 East 70th Street, New York, under the name of "Medical Miscellany List 'J' ", includes, besides a large number of miscellaneous works on medicine and science, two sections devoted respectively to neurology and psychiatry and war medicine. The miscellaneous works include books by Baillou on epidemiology, diseases of the skin by Alibert, anthropology by Blumenbach, physiological optics by Helmholtz, as well as the first fifteen volumes of the *Memoirs of the Royal Academy of Surgery of Paris*. Among the books on neurology and psychiatry are works by Brown-Séquard, Freud, Janet, Kraft-Ebing, Puschmann, Spallazani and Vesalius. The section on war medicine contains Hans von Gerssdorff's field book of surgery (1528), John Pringle's "Observations on the Diseases of the Army" (1765) van Swieten's "Diseases incident to Armies" (1776) and works on the American Civil War (1861–1870), including documents concerning the United States Sanitary Commission.

## Announcements

After nearly two years in China, Dr. Joseph Needham, director of the British Council Cultural Scientific Office in China, has returned to Great Britain for consultations. He will be returning to China early in the New Year.

Prof. J. M. Mackintosh, professor of public health in the University of London, has been appointed dean of the London School of Hygiene and Tropical Medicine as from January 1, 1945.

At the annual general meeting of the Scientific Instrument Manufacturers Association of Great Britain, Ltd., the following officers were elected: *President*, Mr. F. Wakeham; *Vice-Presidents*, Mr. J. Hasselkus and Mr. J. T. Offer; *Hon. Treasurer*, Mr. J. E. C. Bailey; *Hon. Secretary*, Mr. G. A. Whipple.

The Association of Scientific Workers is organizing a conference to discuss the use of science in the post-war world, to be held at the Caxton Hall, London, S.W.1, during February 17–18, 1945. Further particulars will be obtainable in due course from the Association of Scientific Workers, Hanover House, 73 High Holborn, London, W.C.1.

# LETTERS TO THE EDITORS

*The Editors do not hold themselves responsible for opinions expressed by their correspondents. No notice is taken of anonymous communications.*

## Unification of the Theories of Photon and Meson

ONE of the puzzling features of the modern theory of matter is the considerable number of different ultimate particles: photons, neutrinos, negative and positive electrons, mesons, protons and neutrons. To each type of particle corresponds a certain type of field, and all these fields are supposed to exist simultaneously in space.

Attempts at unification were successful only in the frame of classical electrodynamics; it is possible to consider the electron as a singularity of the electromagnetic field. But this idea could not be adapted to quantum theory.

To-day, particles of any type are considered as quanta of the corresponding field (in the same way that photons are the quanta of the electromagnetic field), and their interaction can be described by a coupling of the fields. This interaction produces not only the phenomena of collision and combination of different particles, but also the self-energy of single particles, and is therefore the clue to the understanding of the different masses. But this theory is extremely complicated and has so far yielded no positive results.

It would, therefore, be of advantage to have a simple example where the interaction of two types of fields can be studied rigorously with the help of simple mathematics. I have found that the interaction of two fields with even spin provides such an example.

A field with spin 0 is described by a scalar wave function $\chi$. The simplest Lagrangian density as used in the elementary theory of the scalar meson is

$$\mathfrak{L}_0 = \tfrac{1}{2}(\nabla\chi)^2 + \tfrac{1}{2}\eta_0^2\chi^2, \quad . \quad . \quad . \quad . \quad (1)$$

where $\nabla$ means the 4-dimensional gradient $\partial/\partial x_\alpha$ ($\alpha = 1, 2, 3$; $x_1, x_2, x_3$ space co-ordinates, $x_4/ic$ time). The constant $\eta_0$ is connected to the rest mass $m_0$ by

$$\eta_0 = \frac{m_0 c}{\hbar} \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (2)$$

A field with spin 1 is described by a 4-vector wave function (components $\varphi_1, \varphi_2, \varphi_3, \varphi_4$); the most general Lagrangian density is

$$\mathfrak{L}_1 = \tfrac{1}{2}(\nabla\wedge\varphi)^2 - \tfrac{1}{2}\lambda(\nabla\cdot\varphi)^2 + \tfrac{1}{2}\eta_1^2\varphi^2, \quad . \quad . \quad (3)$$

where $\wedge$ indicates the vector product (with 6 components $\partial\varphi_\beta/\partial x_\alpha - \partial\varphi_\alpha/\partial x_\beta$) and . the scalar product. $\eta_1$ is again proportional to the rest mass.

If $\eta_1 = 0$ and $\lambda = 0$, one has the ordinary Maxwellian theory of the vacuum. The addition of the $\lambda$-term is of no great consequence as the solutions are usually restricted by the condition that the quantity

$$\Phi = \nabla\cdot\varphi \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (4)$$

vanishes (Lorentz condition). If the term with $\eta_1$ is added, one has the vectorial meson theory.

Now I suggest that the interaction of these two fields should be considered, *assuming in both of them that the mass term is zero.*

$$\eta_0 = 0, \ \eta_1 = 0. \quad . \quad . \quad . \quad . \quad (5)$$

The simplest possible interaction is

$$\mathfrak{L}_{01} = \mu\chi(\nabla\cdot\varphi), \quad . \quad . \quad . \quad . \quad . \quad (6)$$

where $\mu$ is a constant of dimension reciprocal length. It is easy to see that no other independent interaction exists which is relativistically invariant and quadratic in the wave functions.

The total Lagrangian

$$\mathfrak{L} = \mathfrak{L}_0 + \mathfrak{L}_1 + \mathfrak{L}_{12} = \tfrac{1}{2}(\nabla\chi)^2 + \tfrac{1}{2}(\nabla\wedge\varphi)^2 - \frac{\lambda}{2}(\nabla\cdot\varphi)^2 + \mu\chi(\nabla\cdot\varphi) \quad . \quad . \quad (7)$$

then leads to the field equations

$$\nabla^2\varphi - \nabla\Phi = s, \quad . \quad . \quad . \quad . \quad . \quad (8)$$

$$\nabla^2\chi = \mu\Phi, \quad . \quad . \quad . \quad . \quad (9)$$

where $$s = \nabla(\lambda\Phi - \mu\chi) \quad . \quad . \quad . \quad . \quad . \quad . \quad (10)$$

can be considered as a charge-current vector. From (8) one obtains the continuity equation for $s$:

$$\nabla\cdot s = 0, \quad . \quad . \quad . \quad . \quad . \quad (11)$$

which, however, is not an identity, but implies in virtue of (9) and (10)

$$\nabla^2\Phi = \frac{\mu}{\lambda}\nabla^2\chi = \frac{\mu^2}{\lambda}\Phi. \quad . \quad . \quad . \quad (12)$$

Now one can establish wave equations for $\chi$ and each component of $\varphi$ separately, by applying the operators $\nabla^2$ and $\nabla^2 - \mu^2/\lambda$ to (8) and (9):

$$\nabla^2\left(\nabla^2 - \frac{\mu^2}{\lambda}\right)\chi = 0, \quad . \quad . \quad . \quad . \quad (13)$$

$$\nabla^2\left(\nabla^2 - \frac{\mu^2}{\lambda}\right)\nabla^2\varphi = 0. \quad . \quad . \quad . \quad (14)$$

These equations have solutions of the form of plane waves, representing particles with energy $E$ and momentum $\mathbf{p}$; for these solutions the operator $\nabla^2$ corresponds to multiplication with $(E/c)^2 - \mathbf{p}^2$. Hence there are two types of waves possible: one moving with the velocity of light corresponding to particles with rest mass zero, photons; the other with smaller velocity corresponding to particles with finite rest mass

$$m_0 = \frac{\hbar\mu}{c\sqrt{\lambda}}, \quad . \quad . \quad . \quad . \quad . \quad . \quad (15)$$

which behave, therefore, like mesons. A simple discussion shows that in the case of the photon $\chi = \Phi = 0$, three of the four components of $\varphi$ are arbitrary (the fourth being determined by the Lorentz condition $\nabla\cdot\varphi = 0$); whereas in the case of the meson $\chi$ and $\Phi$ are not zero and $\varphi$ has only a longitudinal component equal to $\chi$.

The result is that particles of spin 0 and 1 without rest mass are transformed by the simplest interaction into two new types of particles, one still having the rest mass zero (photon), the other a finite rest mass (meson).

Photon and meson seem to be different phenomena of the same quantized field. The theory as indicated here is over-simplified; for example, the wave functions are treated as real quantities, whereas there is evidence for the meson field being complex (for otherwise mesons could not carry electric charges). Moreover, the provisional character of these considerations is obvious as they exemplify how meaningless it is to neglect any kind of particle. All particles together form a single field of great complexity. One can venture the suggestion that, by adding to the scalar and vector fields treated here, a Dirac field

without mass term, the result will be a transformation into new types of particles with finite rest mass and spin ½. This theory, however, will be much more complicated, since the interaction terms of the vector field $\varphi$ and the spinor field $\psi$ are of the third order (type $\varphi(\psi\psi)$ ). One has to apply perturbation theory, and it is well known that this has so far always led to infinite values of the self-energy. But recent investigations carried out by Dr. H. W. Peng, in my Department, have shown that this is due only to insufficient mathematics. Therefore it can be expected that Peng's method of secular perturbations will allow the mass problem to be tackled as sketched here.

MAX BORN.

Department of Mathematical Physics,
University of Edinburgh.
Nov. 14.

## Excretion of Penicillin in Man

PENICILLIN is rapidly eliminated from the human body, and 40–99 per cent of an injected dose can be recovered from the urine within four hours in normal cases. There is some evidence that the drug is actively secreted by the renal tubules[1,2]. In cases of severe azotæmic nephritis, penicillin has been demonstrated in the blood for so long as ten hours after a single injection, although in a normal person after a dose of 25–50,000 units it would have disappeared in three hours.

There were recently admitted to this Hospital two patients, both of whom had had incomplete abortions at the sixteenth week of pregnancy and both of whom developed extreme oliguria directly afterwards. In each case this condition lasted for ten days before recovery began, and during this period such urine as was passed consisted of a glomerular filtrate with evidence of little tubular function. This is shown by Table 1, from which it may be seen that even at high blood urea levels there was only a low urea concentration in the urine (cf. extrarenal azotæmia, in which urinary urea may reach 4 per cent), that chlorides were not retained even though the plasma values were far below normal (560–620 mgm. sodium chloride per 100 c.c.), and that creatinine was concentrated to a small extent compared with the 'normal' ratio of about 100[3].

TABLE 1. CONCENTRATIONS ARE GIVEN IN MGM. PER 100 ML., AND THE DAYS REFER TO THE NUMBER OF DAYS OF OBSERVATION.

| | Case I | | Case II | |
|---|---|---|---|---|
| | 2nd day | 10th day | 2nd day | 10th day |
| Urine vol. (ml.) | 15 | 180 | 165 | 150 |
| Urea in blood | 174 | 530 | 255 | 320 |
| Urea in urine | 170 | 600 | 800 | 600 |
| Chlorides (as NaCl) in plasma | 590 | 360 | 400 | 320 |
| Chlorides (as NaCl) in urine | 160 | 255 | 215 | 305 |
| 'Apparent' creatinine in plasma | 8 | 18 | 8 | 12 |
| 'Apparent' creatinine in urine | 6 | 9 | 67 | 50 |

These temporarily self-nephrectomized persons provided an opportunity of observing the fate of injected penicillin, for physiological as well as therapeutic reasons. 45,000 units of a preparation issued by the Therapeutic Research Corporation were injected intra-muscularly, and bacteriostatic assays were made upon serum samples at intervals afterwards. Bacteriostasis was measured in slide-cells, using the Oxford standard strain of *Staphylococcus aureus* as test organism. The results are given in Table 2.

TABLE 2.
+ = bacteriostasis.
± = partial bacteriostasis compared with control.

| | Hours after injection | Serum dilution 1/1 | 1/2 | 1/4 | 1/8 | 1/16 | 1/32 |
|---|---|---|---|---|---|---|---|
| Case I. | 3 | + | + | + | + | + | + |
| | 7 | + | + | + | + | + | + |
| | 18 | + | + | + | + | + | − |
| | 26 | + | + | + | + | − | − |
| | 32 | + | + | ± | − | − | − |
| | 45 | + | + | − | − | − | − |
| | 72 | + | ± | − | − | − | − |
| | 107 | + | − | − | − | − | − |
| | 131 | − | − | − | − | − | − |
| Case II. | 1 | + | + | + | + | + | + |
| | 6 | + | + | + | + | + | + |
| | 20 | + | + | + | + | ± | − |
| | 26 | + | + | + | + | ± | − |
| | 48 | + | + | + | + | − | − |
| | 68 | + | ± | − | − | − | − |
| | 92 | + | − | − | − | − | − |
| | 116 | + | − | − | − | − | − |
| | 116 (with penicillinase) | − | − | − | − | − | − |

In both cases urine samples collected during the test periods were assayed for penicillin by the ring test[4], but none contained detectable amounts.

The second patient was given a further injection of 47,500 units five days after the first. The 24-hour urine volumes on the succeeding days were 150, 480, 600 and 1,260 c.c. Her serum, taken three days after this injection, still caused complete inhibition of growth of staphylococci at a dilution of 1:1, and partial inhibition at 1:2 (effect abolished by penicillinase). On this occasion the urine excreted during the twenty-four hours following injection caused inhibition of growth in the ring test corresponding to ½–1 unit of penicillin per c.c., but subsequent specimens caused negligible inhibition.

The failure to recover penicillin from the urines (*p*H 6·8–7·6, and preserved with toluene) of case II must have been due both to grossly impaired glomerular and tubular function. As judged by creatinine values, however, concentration of the urine by tubular reabsorption of water was still occurring to the extent of at least five times, although chloride reabsorption and urea excretion were greatly deficient. If penicillin were concentrated in the urine solely by reabsorption of water, it seems probable that it would have been sufficiently concentrated in the urine to have been detected in the ring test. However, such evidence for active tubular secretion is suggestive only.

The main conclusion to be drawn from these two cases is that in the absence of significant renal excretion of penicillin this drug is slowly inactivated in the body, but will nevertheless remain detectable for five days.

J. H. HUMPHREY.

Central Middlesex
County Hospital,
London, N.W.10.
Nov. 8.

[1] Rammelkamp, C. H., and Keefer, C. S., *J. Clin. Invest.*, 22, 425 (1943).
[2] Rammelkamp, C. H., and Bradley, S. E., *Proc. Soc. Exp. Biol.*, 53, 30 (1943).
[3] Winton, F. R., and Bayliss, L. E., "Human Physiology" (London, 1936).
[4] Heatley, N. G., *Biochem. J.*, 38, 61 (1944).

## Ammonia Excretion and the Clearance of Mepacrine

IT has been found that the urinary excretion of mepacrine has a relation to the excretion of ammonia. The simplest description of this empirical relation is that the mepacrine clearance from the plasma is directly proportional to the rate of excretion of ammonia. This may be expressed thus:

$$\frac{UM \times V}{PM} = k\,U\mathrm{NH_3} \times V, \quad . \quad . \quad . \quad (1)$$

where $UM$ is urinary mepacrine in micrograms/litre; $V$ is volume of urine in ml./min.; $PM$ is plasma mepacrine in micrograms/litre; $U\mathrm{NH_3}$ is urinary ammonia in mgm. $NH_3$-N/100 ml.; and $k$ a constant equal to 2·4.

Equation (1) may be written in the form:

$$PM = \frac{1}{k}\,\frac{UM}{U\mathrm{NH_3}} \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (2)$$

In this form the relation can be used to estimate plasma mepacrine concentration from the urinary concentration of mepacrine and ammonia only, without regard to their rates of excretion. The relation has been studied and found to hold between the following limits: $UM$ from 260 to 4,900 micrograms/litre; $V$ from 1 to 10 ml./min.; $PM$ from 12·2 to 40·2 micrograms/litre; $U\mathrm{NH_3}$ from 3·4 to 59·5 mgm. $NH_3$-N/100 ml.

The accompanying table shows the plasma mepacrine concentrations ($PM$ calc.), calculated from equation (2) for two separate urine samples obtained from each of ten subjects, compared with the plasma mepacrine concentrations directly determined by Masen's method[1] on blood samples drawn in the middle of each urine-collecting period ($PM$ obs.).

OBSERVED PLASMA MEPACRINE CONCENTRATION ($PM$ OBS.) COMPARED WITH THE CALCULATED VALUE ($PM$ CALC.).

| Volunteer No. | Period | $PM$ (obs.) microgram/litre | $PM$ (calc.) microgram/litre |
|---|---|---|---|
| 1 | I | 40·2 | 38·2 |
| | II | 32·8 | 41·8 |
| 2 | I | 32·3 | 33·8 |
| | II | 29·3 | 33·4 |
| 3 | I | 28·5 | 25·8 |
| | II | 26·6 | 22·7 |
| 4 | I | 25·4 | 26·2 |
| | II | 25·0 | 24·6 |
| 5 | I | 23·8 | 16·2 |
| | II | 23·0 | 24·6 |
| 6 | I | 19·9 | 30·6 |
| | II | 18·4 | 14·5 |
| 7 | I | 18·2 | 19·4 |
| | II | 17·4 | 16·1 |
| 8 | I | 16·3 | 14·6 |
| | II | 15·8 | 17·4 |
| 9 | I | 14·3 | 13·7 |
| | II | 13·9 | 14·6 |
| 10 | I | 13·0 | 14·6 |
| | II | 12·2 | 14·0 |

The standard deviation of the differences between $PM$ (obs.) and $PM$ (calc.) was found to be $\pm$ 4·0 micrograms per litre, with a mean plasma concentration of 22·2 micrograms per litre, whereas the standard deviation of $PM$ (obs.) (mean of triplicates) was itself $\pm$ 3·5 micrograms per litre.

The striking relation expressed in equation (1) has, so far as we know, not previously been reported. There is no reason to suppose that this relation is confined to the excretion of mepacrine. It possibly depends on the fact that mepacrine may behave like a substituted ammonia compound, in which case the relation may be applicable to the excretion of other such compounds.

For example, the observations by Haag *et al.*[2] that quinine is excreted more rapidly in acid urine than in alkaline suggests that this drug behaves like mepacrine. This possibility is being investigated.

B. G. MAEGRAITH. D. S. PARSONS.
G. M. BROWN. C. N. PARTINGTON.
R. J. ROSSITER. J. L. RENNIE.
K. N. IRVINE. R. E. HAVARD.
J. C. LEES.
Army Malaria Research Unit,
Oxford. Nov. 7.

[1] Masen, J. M., *J. Biol. Chem.*, **148**, 529 (1943).
[2] Haag, H. B., Larson, P. S., and Schwartz, J. J., *J. Pharm. Exp. Ther.*, **79**, 136 (1943).

## Viscero-Motor Reflexes

STIMULATION of the sensory nerves of the abdominal viscera has given mixed results in the hands of different observers. Miller and his colleagues[1,2] obtained movements of the hind legs and belly muscles on centripetal stimulation of the mesenteric nerves of decapitated cats. Squeezing the intestine and traction on the mesentery were also effective. Lewis and Kellgren[3], on the other hand, obtained no movement of the legs or belly muscles on pinching the duodenum, but did record a rise of blood pressure. Pinching the pancreas caused both muscle movements and rise of blood pressure. McDowall[4], in 1942, stated that occlusion of the carotid and vertebral arteries of a decerebrated cat produces a 'spinal' preparation devoid of shock, and that certain stimuli, such as stretching the gut, cause marked limb movements. He pointed out that a successful result is obtained only if the preparation is not overventilated.

We also find that the presence or absence of spinal reflex movements following stimulation of the intestine depends on the preparation of the animal. When the brain of the cat is destroyed above the second cervical vertebra, no, or only very small, movements of the hind limbs follow a strong pinch of the duodenum, but a pinch of a small part of the head of the pancreas causes strong movements; a rise of blood pressure follows each pinch. This confirms the findings of Lewis and Kellgren. On the other hand, when the spinal cord is transected in the upper thoracic region and the cat then decerebrated, a gentle squeeze of any part of the small and large intestine causes strong movements of the hind legs. Other effective stimuli include scraping or scratching the serous coat or heating the gut, and also pulling or rubbing the mesentery. We find that the small intestine is less sensitive along its free border than near the attachment of the mesentery. Responses follow mechanical or thermal stimulation of an adequate area of the gut or repeated stimulation of a smaller area. All stimuli have been applied to the outside of the intestine, and it is not yet possible to define the site of origin of the afferent impulses.

When the response to visceral stimulation is tested some three hours after the operation under ether anæsthesia, superficial and deep reflexes of the hind legs are very lively and easily elicited in both preparations. It is curious that there is so little correspondence between the general reflex activity of the hind limbs and the responses to visceral stimulation. The viscero-motor responses may deteriorate to extinction without apparent change in the general reflex activity of the limbs. It must be recalled that

the animal with the head pithed is maintained alive by artificial respiration, and it is possible that the failure to elicit viscero-motor responses is related to the abnormal ventilation.

B. A. McSwiney.
C. B. B. Downman.
St. Thomas's Hospital Medical School,
Godalming, Surrey.

[1] Miller, F. R., and Simpson, H. M., *Trans. Roy. Soc. Canada*, Sec. V, **18**, 147 (1924).
[2] Miller, F. R., and Waud, R. A., *Amer. J. Physiol.*, **73**, 329 (1925).
[3] Lewis, T., and Kellgren, J. H., *Clin. Sci.*, **4**, 47 (1939).
[4] McDowall, R. J. S., *J. Physiol.*, **101**, 6P (1942).

## Role of Acetylcholine and Vitamin $B_1$ in Nervous Excitation

A YEAR ago a short report of our work under the same title was given in *Nature*[1]. Since then new data have become available, which will be summarized briefly.

Stimulation of the branch of the vagosympaticus supplying the heart of the frog leads to the liberation of a second substance, besides acetylcholine, which diffuses into the fluid in the canula on which the heart is fixed. We have identified this substance as aneurin (thiamin) or an aneurin-compound[2]. Heart-fluids collected during resting periods do not contain the substance. Stimulation of the sympathetic component alone (nn. accelerantes) has no effect on the liberation of the substance. The result of stimulation of the mixed nerve varies from individual to individual. Pure vagus stimulation can be produced from the medulla oblongata. Stimulation with a special electrode produced in the heart more of the substance than is found otherwise. Oxidation with potassium ferricyanide in alkali transforms the substance into thiochrome, soluble in butanol, with the characteristic fluorescence of thiochrome. Ultra-violet of short wave-length (less than 290 mμ) destroys aneurin in solutions[3], *in vivo* in the nerve[4], and the same was found with the substance in heart-fluids collected during stimulation periods.

The amount of aneurin or aneurin-compound set free on vagus-stimulation was determined by two independent methods: (*a*) with our very sensitive fluorometer, making use of monochromatic illumination and a vacuum photocell, connected with a specially balanced amplifier[5]. After a total of five minutes stimulation (with intervals) of the vagus, $1 \times 10^{-8}$ gm. aneurin was liberated in each cm.$^3$ of heart fluid. (*b*) Growing *Phycomyces blakesleeanus* on heart fluids obtained during stimulation periods produced good growth. Fluids from resting periods of equal duration gave no or only negligible growth. Calibrating the growth-curves with aneurin solutions gave about the same amount of aneurin liberated during stimulation as with the thiochrome method. We cannot say at the moment if it is free aneurin or a compound of aneurin; aneurindiphosphate (co-carboxylase) is excluded.

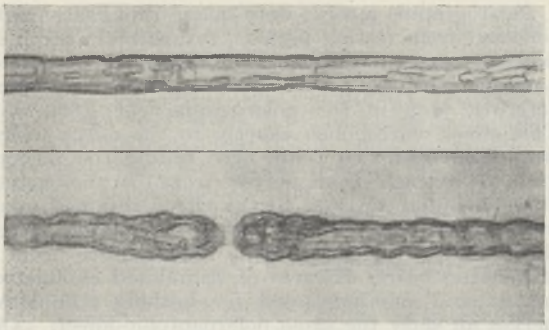
Adrenalin shows fluorescence on addition of alkali, an optical effect which might introduce an error; but it is insoluble in butanol in those concentrations which might interfere, and the fluorescence of the substance in our experiments is only produced by the addition of potassium ferricyanide. Interaction of adrenalin is ruled out by these chemical facts and by the biological observation that stimulation of the sympathetic chain does not produce a liberation of a substance with the same optical properties as the substance found on vagus stimulation.

Polarographic records were taken from heart fluids collected from resting periods, sympathetic stimulation and vagus stimulation. The 'vagus fluids' showed a regular and very considerable increase of the characteristic step in the polarogram near 1,950 mV. This effect corresponds exactly to the effect which was discovered two years ago[6] taking the polarogram of extracts from nerves, frozen in the excited state in liquid air, and to the effect obtained upon stimulation from the cut end of cholinergic nerves dipping into Ringer solution. 'Vagus fluids' from a stimulated heart, extracts of stimulated cholinergic nerves and solutions used for bathing stimulated nerves all show the same polarographic effect. The increase cannot be due to the liberation of free aneurin, the lowest concentration of chemical pure aneurin detectable by polarographic analysis being $1 \times 10^{-6}$. The aneurin liberated on stimulation in the cholinergic nerve and at the end of the vagus in the heart is an active compound with a strong catalytic effect on the dropping mercury electrode at 1,950 mV. At the same time, this compound has the same effect as vitamin $B_1$ on *Phycomyces blakesleeanus* and yields thiochrome on oxidation. The artificial aneurin compounds so far studied did not satisfy these three requirements at the same time. The aneurin compound set free in the heart on vagus stimulation must be considered as a special form of aneurin.

Löwi called the substance (acetylcholine) liberated on vagus stimulation in the heart "Vagusstoff", so long as he was not sure of its exact chemical nature. We propose to call the second substance which is liberated together with acetylcholine and which has the properties of an aneurin compound, "2. *Vagusstoff*".

The normal polarographic technique requires several minutes in order to take one record. This was not satisfactory in the study of the time relation between stimulation and appearance of the active aneurin compound in the bathing fluid into which the cut end of a stimulated nerve was dipping. We designed, therefore, a new apparatus in which the polarogram appears on the screen of a cathode ray oscillograph. With this apparatus the whole effect is visible as soon as the substances reach the dropping mercury electrode. Varying the distance between the cut end of the nerve and the dropping mercury electrode and taking the nerve out of the fluid at the end of the stimulation showed that the active substance is produced at the moment, or a few milliseconds later, when the excitation wave reaches the cut end of the nerve. Even if the liberation of this aneurin compound is connected with recovery from excitation in nerve, as we think to-day, the time relations between excitation, liberation of the substance and recovery are very short.

Ultra-violet photomicrographs of living single nerve fibres (nerve-muscle preparation) have been taken with $\lambda = 280$, 275 and 257 mμ. The accompanying photomicrographs reveal the existence *in vivo* of the protoplasmic marginal net, described by Cajal and Nageotte on fixed preparations, and the extensive development of this net on the node. Taking the ultra-violet absorption spectrum of *living* nerve fibres with an apparatus designed very much along the lines developed by Caspersson[7], a distinct maximum of absorption was found at $\lambda = 265$ mμ. It corresponds to the maximum of absorption of aneurin. This maximum disappeared after treating the fibres with potassium ferricyanide. The disappearance on chemical treatment confirms this view, because this



ABOVE, LIVING SINGLE NERVE FIBRE OF FROG. CADMIUM SPARK, $\lambda = 275$ m$\mu$, QUARTZ CONDENSER AND CORRECTED QUARTZ OBJECTIVE AND OCULAR. SIZE OF FIBRE DIAMETER, 8 $\mu$.

BELOW, NODE OF RANVIER, DIED DURING EXPOSURE (1 MIN.), SAME TECHNIQUE AS UPPER PHOTOMICROGRAPH.

substance is transformed into thiochrome in nerve as was shown previously[8], and then the maximum shifts to 375 m$\mu$. The measurements are complicated by the photochemical action of the short-wave ultra-violet on the single nerve fibre[4]. This action is immediate at the nodes of Ranvier; the internodal section is protected by the nerve sheath. The photochemical decomposition of the sheath can be followed by serial photographs. In one series, by chance one photograph was taken just before the last excitation wave passed the single fibre and the next photograph was taken one second after impairment of conduction. Impairment of conduction was due to disconnexion of the axis cylinder produced by ultra-violet radiation (275 m$\mu$), clearly visible on the photomicrograph.

The acetylcholine and aneurin content was measured in mammalian nerve fibres during Wallerian degeneration. Acetylcholine disappears very rapidly after section of the nerve, as previously found by other authors[9]. In our experiments the ability of nerve to synthesize acetylcholine was maintained so long as the nerve remained excitable. Aneurin has quite a different curve. The loss is great in the first twenty-four hours and slows up from then on, so that a certain level is maintained even after seventy-two hours of degeneration. Protracted degeneration was observed after the administration of aneurin, using as a test the degeneration of the nerve fibres in the cornea of the rabbit, visible with a special slit-lamp and vital staining method.

The experiments reported confirm the conception that acetylcholine formation is essential for the excitation or recovery process and that aneurin is a reservoir substance closely connected with the formation and disappearance of acetylcholine[10].

Full details will be presented elsewhere. I am indebted to the Rockefeller Foundation for grants in aid of this work.

A. v. MURALT.

Physiologisches Institut,
Hallerianum, Berne.
Aug. 10.

[1] v. Muralt, *Nature*, **152**, 188 (1943).
[2] Wyss and v. Muralt, *Helv. Physiol. Acta*, in the Press.
[3] Uber and Verbrugge, *J. Biol. Chem.*, **134**, 273; **136**, 197 (1935).
[4] Stämpfli, dissertation, Berne (1942). Hutton-Rudolph, *Helv. Physiol. Acta*, 1, C 15 (1943). Hutton-Rudolph, dissertation, Berne (1944).
[5] Wyss, *Helv. Physiol. Acta*, **1**, C 70 (1943).
[6] v. Muralt, *Pflügers Arch.*, **245**, 604 (1942).
[7] Caspersson, *J. Roy. Micro. Soc.*, **60**, 8 (1940).
[8] v. Muralt, *Pflügers Arch.*, **247**, 1 (1943).
[9] cf. Feldberg, *J. Physiol.*, **101**, 432 (1943).
[10] cf. v. Muralt, *Schweiz. Med. Wschr.*, **73**, 1101 (1943); **74**, 643 (1944).

## Metabolism of Symmetrical Trinitrotoluene

THE recent publication by Channon *et al.*[1] of a paper on the T.N.T. metabolism in the rabbit induces us to record similar investigations carried out during the past two years with rats, human volunteers and munition workers.

For the estimation of diazotizable amines a spectrophotometric method, based on the principles of the method of Bratton and Marshall[2] for sulphonamides, was used. A simplified colorimetric method was made available to the Commonwealth Department of Health in June 1943.

The excretion of diazotizable amines was found to be roughly proportional to the intake of T.N.T. In the rat the recovery (15–20 per cent of ingested T.N.T.) was lower than found by Channon *et al.* with the rabbit, while on the average 40 per cent of small doses (10–30 mgm.) given to human volunteers was excreted in this form.

The reduction products in the urine were separated as follows: after acid hydrolysis (one hour in 1/8 *N* hydrochloric acid) the acid urine was extracted with ether in a continuous extraction apparatus giving Extract I. The residual urine was then neutralized with sodium carbonate and the more strongly basic compounds extracted with ether in the same manner (Extract II). Both ether extracts were washed with sodium bicarbonate, afterwards with sodium hydroxide. The sodium hydroxide extracts contained much more diazotizable amino-compounds than the bicarbonate extracts, the substances extracted evidently being amino-nitrocresols. The weakly basic dinitrotoluidines were extracted from the first ether extract with 20 per cent and concentrated hydrochloric acid, the strongly basic nitrotoluylene diamines from the second extract with 1 per cent hydrochloric acid. 4-amino-2.6-dinitrotoluene and 2.4-diamino-6-nitrotoluene added to normal rats' urine could be recovered quantitatively by this procedure, the former in the first, the latter in the second extract.

The ether-extractable pigments of munition workers' urine consisted of 60–75 per cent dinitrotoluidines, 10–25 per cent nitrotoluylene diamines and 10–15 per cent of amino-nitrocresols. In the rat the results were, however, different: nitrotoluylene diamines predominated (50–60 per cent), while dinitrotoluidines and amino-nitrocresols formed the remainder in about equal proportion.

From the human dinitroluidine fraction we isolated 4-amino-2.6-dinitrotoluene (m.p. 175°, no m.p. depression with pure compound m.p. 175°) and a product with melting points varying between 128° and 136°, more lightly coloured than the 4-amino-compound, less basic and extracted from ether fully only by concentrated hydrochloric acid. Acetylation with pyridine-acetic anhydride revealed that the latter was still a mixture; the acetyl compound consisted of flat square-ended yellow needles and some fine colourless needles. The greater part melted at 159°, but a small part remained solid up to 196°. Since the acetyl compound of 6-amino-2.4-dinitrotoluene forms yellow needles, melting at 159–160° (Channon *et al.*[1]), while that of the 4-amino-compound crystallizes in almost colourless needles of m.p. 227°, the product was evidently the 6-amino-compound with some 4-amino-compound admixed. The Webster test, which we carry out in alcohol-ether mixture 1 : 1, adding small amounts of alcoholic potash, gave with ether extracts of human urines the brownish-purple colour

indicated the presence of 4-hydroxylamino-2.6-dinitroluene. The products present in the human urines are thus mainly the same found by Channon *et al.* in the rabbit.

In the dinitrotoluidine fraction from the rat we found only 4-amino-2.6-dinitrotoluene. The nitrotoluylene diamine fraction gave a compound very similar in properties to 2.4-diamino-6-nitrotoluene. It was less soluble than the latter in chloroform and crystallized in orange needles of m.p. 145° which gave a large melting-point depression with pure 2.4-diamino-6-nitrotoluene of m.p. 138°. The acetyl compound crystallized in deep yellow triangles or twinned prisms, m.p. 336°. The assumption that this compound is the isomeride (2.6-diamino-4-nitrotoluene) was ruled out by the observation that it can be obtained in good yield by feeding 2.4-diamino-6-nitrotoluene to rats. Analyses have shown that the substance is 5-nitro-*m*-phenylene diamine, for which Flürscheim[3] reported m.p. 141°. The rat is thus able to remove the methyl group from T.N.T. The mother liquors contained 2.4-diamino-6-nitrotoluene.

R. LEMBERG.
J. P. CALLAGHAN.

Institute of Medical Research,
Royal North Shore Hospital,
Sydney.

[1] Channon, H. J., Mills, G. T., and Williams, R. T., *Biochem. J.*, **38**, 70 (1944).
[2] Bratton, A. C., and Marshall, E. K., jun., *J. Biol. Chem.*, **128**, 537 (1939).
[3] Flürscheim, *J. prakt. Chem.*, 71, 538 (1905).

## Specific Protective Influence of Alanine in Differential Tissue Destruction by Hexenolactone (Parasorbic Acid)

MEDAWAR'S differential 'mesoderm inhibitor', originally obtained from malt, ungerminated grain and oranges, has been closely reproduced through synthesis by Medawar, Robinson and Robinson[1], who are not entirely certain whether their malt-distillate factor is optically active δ-hexenolactone or an allied substance. Because of structural similarity with panto-lactone, which combines with β-alanine to form pantothenic acid, synthetic *dl*-δ-$\Delta^{\alpha\beta}$ hexenolactone and its natural equivalent (probably parasorbic acid) were suspected of entering somehow into pantothenic acid metabolism, possibly by competition with panto-lactone.

Kuhn and Jerchel[2], independently of Medawar *et al.* and following a different procedure, also prepared an optically inactive unsaturated δ-hexenolactone and established its structural identity with parasorbic acid. Kuhn, Jerchel, Moewus, Moller and Lettre[3] confirmed the differential inhibition of fibroblasts at concentrations of this lactone which did not affect neoplastic epithelium, and found that addition of excess pantothenic acid did not interfere with inhibition. Similar negative results with pantothenic acid were obtained in this laboratory.

To elucidate the tissue-differential effect of hexenolactone with respect to a possible mechanism involving alanine, several aquatic invertebrates were tested in media containing α-alanine, β-alanine, glycine, *iso*-leucine, *d*-glutamic acid or glutathione in addition to *M*/20,000 hexenolactone (that is, 0·0056 mgm./c.c. or one half the concentration needed to inhibit chick fibroblasts). Carefully matched control animals were cultured simultaneously in *M*/20,000 hexenolactone alone. The lactone was synthesized by McNeil Laboratories according to the method of Kuhn and Jerchel[2].

Best results were obtained with the flatworm *Dugesia tigrina*, which responds by developing a three-branched, *Y*-shaped lesion in the dorsal wall. The lesion corresponds in pattern to the triclad intestine. Extent of lesion is directly correlated with state of nutrition, being greatest in well-fed animals, regardless of body size.

The inhibitor, therefore, appears to take effect from within the animal, producing first a partial evisceration; secondly, disintegration of gut and surrounding mesenchyme; and lastly, the lesion in the dorsal epithelium. There is no antero-posterior susceptibility gradient, but a tissue-differential response. Measurements on lesion area, survival and extent of healing permit quantitative comparison between tests and controls. The following results represent percentage differences in lesion area, based on fifty-two separate experiments with a total of 2,010 specimens of *Dugesia tigrina*:

| | | | |
|---|---|---|---|
| Protection (reduced lesion area) | — 67·5 per cent. | β-alanine *M*/40,000 | |
| | — 61·9 ,, ,, | Glutathione *M*/50,000 | (thio-alanine) |
| | — 46·8 ,, ,, | β-alanine *M*/20,000 | |
| | — 46·3 ,, ,, | Glutathione *M*/20,000 | (thio-alanine) |
| | — 5·8 ,, ,, | β-alanine *M*/5,000 | |
| No protection (increased lesion area) | + 2·4 per cent. | *Iso*-leucine *M*/20,000 | |
| | + 18·6 ,, ,, | *Iso*-leucine *M*/50,000 | |
| | + 29·6 ,, ,, | Glycine *M*/40,000 | |
| | + 33·0 ,, ,, | Glycine *M*/100,000 | |
| | + 34·5 ,, ,, | Glutamic ac. *M*/50,000 | (*p*H adjusted) |
| | + 96·4 ,, ,, | Glutamic ac. *M*/50,000 | (*p*H not adjusted) |

Data on survival and wound-healing were consistent with these results. Only alanine and glutathione (the cysteine component of which is actually thio-alanine) had a specific protective influence. α-Alanine, tested on the annelid *Dero limosa*, behaved similarly to β-alanine. Glycine, *iso*-leucine and *d*-glutamic acid did not counteract the inhibitor but actually added to its toxicity.

Even the alanines ceased to give protection against *M*/20,000 hexenolactone at concentrations above *M*/5,000, although *M*/1,000 α- and β-alanine as such had no visible toxic effect. This seeming inconsistency with regard to concentration was obtained consistently not only with the alanines, but also with glutathione. Apparently the protective behaviour is confined to an optimum concentration within relatively narrow limits.

Since pantothenic acid does not interfere with the activity of hexenolactone, while α-alanine, β-alanine and glutathione (thio-alanine) do so, a specific alanine mechanism distinct from the alanine link in the biosynthesis of pantothenic acid is very probably at work in differential inhibition and differential tissue destruction by hexenolactone.

Mendez[4], studying digitalis- and angelica-lactones, found their cardiac activity dependent on peroxides formed in aqueous solution in the presence of metallic impurities. If the hexenolactone effect were likewise due to peroxide, protection by glutathione is feasible on the basis of a reaction between SH and $H_2O_2$. On the other hand, it is not clearly understood how alanine might behave toward peroxide, unless it gives rise to pyruvate upon oxidative deamination. If so, why should the hypothetical reactivity between alanine and peroxide decrease with a slight increase in the concentration of the former?

In view of the wide occurrence of simple unsaturated lactones and their probable function as natural

inhibitors, further work on their role in developmental and neoplastic growth should prove fruitful.

THEODORE S. HAUSCHKA.
Lankenau Hospital Research Institute,
Philadelphia, Pa. Oct. 1.

[1] Medawar, P. B., Robinson, G. M., and Robinson, R., *Nature*, **151**, 195 (1943).
[2] Kuhn, R., and Jerchel, D., *Ber. Chem. Ges.*, **76** B, 413 (1943).
[3] Kuhn, R., Jerchel, D., Moewus, F., Moller, E. F., and Lettre, H., *Naturwiss.*, **31**, 468 (1943).
[4] Mendez, R., *J. Pharmacol. and Exper. Therap.*, **81**, 151 (1944).

## Absolute Photopic Sensitivity of the Eye in the Ultra-violet and in the Visible Spectrum

IN a paper published in 1941[1], measurements of photopic and scotopic sensitivity were given; nine observers were used, after one hour adaptation to the dark, according to the method of colour appearance. These measurements were made in the range between the mercury lines 709 and 302 mμ. In this paper I am considering the question of absolute photopic sensitivity, as the inverse of the illumination of the retina $P_\lambda = 1/J_\lambda$.

The absolute photopic sensitivity, $P_\lambda$, in terms of number of (quanta/sec. sq. mm.) [1] is related to the illumination of the pupil $E_\lambda$ (the latter being expressed in erg./sec. sq. cm.) by the equation

$$P_\lambda = \left[\frac{E_\lambda \times 10^{-2}}{h\nu} \cdot (1-r) \cdot \frac{\sigma}{a}\right]^{-1},$$

where $r$ represents the reflexion losses at the cornea (assumed to be 0·05), $\sigma$ the area of the pupil (assumed to be 0·33 cm.$^2$) and $a$ the area of the image on the retina. The area of the image $a$ was 0·0083 mm.$^2$.

THE ILLUMINATION OF THE PUPIL, THE RETINAL ILLUMINATION AND THE ABSOLUTE PHOTOPIC SENSITIVITY OF THE NORMAL EYE IN THE ULTRA-VIOLET AND IN THE VISIBLE SPECTRUM (AVERAGE VALUES FOR 9 OBSERVERS).

| $\lambda$ mμ | $E_\lambda$ $\frac{\text{erg}}{\text{sec. cm.}^2}$ | $P_\lambda \left(\frac{\text{quanta}}{\text{sec. mm.}^2}\right)^{-1}$ | Log $P_\lambda$ |
|---|---|---|---|
| 302 | $8{\cdot}47 \times 10^{-1}$ | $2{\cdot}16 \times 10^{-13}$ | —12·7 |
| 313 | $8{\cdot}86 \times 10^{-2}$ | $1{\cdot}87 \times 10^{-12}$ | —11·7 |
| 334 | $2{\cdot}13 \times 10^{-2}$ | $7{\cdot}75 \times 10^{-12}$ | —11·1 |
| 365 | $6{\cdot}69 \times 10^{-3}$ | $2{\cdot}25 \times 10^{-11}$ | —10·6 |
| 390 | $6{\cdot}84 \times 10^{-4}$ | $2{\cdot}10 \times 10^{-10}$ | — 9·7 |
| 404–407 | $1{\cdot}36 \times 10^{-3}$ | $1 \times 10^{-9}$ | — 9·0 |
| 435 | $1{\cdot}88 \times 10^{-5}$ | $6{\cdot}71 \times 10^{-9}$ | — 8·2 |
| 491 | $3{\cdot}35 \times 10^{-6}$ | $3{\cdot}34 \times 10^{-8}$ | — 7·5 |
| 546 | $1{\cdot}34 \times 10^{-6}$ | $7{\cdot}52 \times 10^{-8}$ | — 7·1 |
| 576–579 | $2{\cdot}74 \times 10^{-6}$ | $3{\cdot}47 \times 10^{-8}$ | — 7·5 |
| 690–709 | $4{\cdot}91 \times 10^{-4}$ | $1{\cdot}60 \times 10^{-10}$ | — 9·8 |

The accompanying table shows the results of my measurements of photopic sensitivity. The curve of photopic sensitivity has its maximum at about 546 mμ. A more exact determination of the maximum does not appear to be obtainable, as the mercury spectrum has no corresponding lines. In my paper[1] it is stated: "the chromatic sensitivity decreases regularly with the decrease of the wavelength to 302 mμ". Speaking strictly, the photopic sensitivity curve in the 365–334 mμ region has a small but still visible flattening, after which it drops abruptly again.

The *scotopic* sensitivity in this region has its maximum (in the case of some observers) or a pronounced flattening of the curve (in other cases). Apparently some maximum of transmission in the lens occurs in the region of 365–334 mμ.

Measurements of the photopic sensitivity curve in the ultra-violet were made by C. F. Goodeve (unpublished). These measurements clearly show a marked flattening of the curve and a point of inflexion at about 350 mμ.

Our results as concerns the character of the curve in the ultra-violet thus confirm the work of Goodeve *et al.*[2].

N. I. PINEGIN.
State Optical Institute, U.S.S.R.

[1] Pinegin, N. I., *C.R. Acad. Sci. URSS.*, **30**, 3 (1941).
[2] Goodeve, C. F., Lythgoe, R. J., and Schneider, E. E., *Proc. Roy. Soc.*, B, **130**, 392 (1942).

## New Light on the Mammalian Ear Ossicles

IN spite of many criticisms, the Reichert-Gaupp theory of the mammalian ear ossicles[1,2,3,4] has, in its main points, been confirmed by a considerable body of work on the developmental anatomy of recent mammals and reptiles, and on the structure of therapsid reptiles. There can be little question that the stapes, incus and malleus (except for its dermal component, the goniale of Gaupp) are essentially homologous respectively with the reptilian columella auris (proximal part or otostapes), quadrate and articular. The existence of vestiges of other elements of the reptilian lower jaw and extrastapes in the mammalian middle ear has been suggested by numerous investigators. Thus the goniale is usually equated with the pre-articular[1,2,3,4, etc.], and the elements of Paauw and Spence have been regarded as parts of the extrastapes[5]. But in general there has been little agreement on the detailed homology of the parts of the stapes, of the crura of the incus, and of the various processes of the malleus; this is largely because most of our information on these points is based on the anatomy of adult and embryonic stages of living mammals and reptiles, while mammals originated from the extinct therapsid reptiles, which differ from Lacertilia and *Sphenodon* in important respects. Until recently, too little was known in detail about the middle ear and lower jaw of therapsids, though Broom[6] showed the position of the tympanic membrane and the presence of an ossified portion of the extrastapes in some Therocephalia (see also ref. 7). E. C. Olson[8] has now provided, among other interesting things, an account of the structure of the otic region of several therapsids (Anomodontia, Therocephalia, Gorgonopsia, Cynodontia) based on serial sections. The structure of the middle ear region is greatly illuminated by this work; but some of his conclusions seem to be open to question, while others can be further supported.

In all the forms discussed by Olson the stapes is perforate, and has a well-marked articulation with the quadrate (by a "processus internus" meeting a special extrastapedial process or lamina from the quadrate), and a strong process which is clearly the base of the distally cartilaginous extrastapes. A processus dorsalis and a separate hyoid process are not present in the fossils. The quadrate in all forms lies in a deep groove in the squamosal, but seems to have been attached to the squamosal and otic region by connective tissue and ligaments only. Valuable new details of the lower jaw are also provided by Olson's sections.

The stapes is exceedingly mammal-like in character: it might be added that a columelliform stapes is present in some therapsids as well as in the adults of some Marsupialia and the Monotremata. It seems highly probable that the stapedial muscle was inserted on the posterior part of the therapsid stapes, probably on the processus extrastapedialis. The

position and relationships of Paauw's cartilage[6] now show clearly that this element is homologous with the proximal part of the extrastapes, and the processus internus of the therapsid stapes is as clearly indicated as the homologue of the head of the mammalian stapes. Olson, following van der Klaauw[5], seeks the equivalent of the processus internus in Spence's cartilage, and is driven to the conclusion that the incudo-stapedial articulation in mammals has shifted proximally on the stapes. But the relationships of Paauw's cartilage show that the mammalian articulation is the primary one, and Spence's cartilage needs further consideration. If it is not a structure peculiar to mammals, it can only be regarded as the remains of the distal (tympanic) portion of the extrastapes. Its position in mammals is quite consonant with this interpretation, and with the views previously expressed[7] on the evolution of the mammalian middle ear. The recent suggestion of Findlay[9], that Spence's cartilage and the manubrium mallei together represent the distal part of the extrastapes, is improbable in view of the developmental evidence that the manubrium is part of the mandibular arch, and of the nature of the therapsid retro-articular process.

Olson also criticizes Gaupp's recognition[1] (now widely accepted) of the goniale (dermal part of the processus Folii or gracilis of the malleus) as the reptilian prearticular. On the basis of the position of the goniale, partly lateral to Meckel's cartilage in some forms, and of variations in the course of the chorda tympani in mammals, he suggests that the goniale and tympanic annulus *together* are equivalent to the reptilian angular. This suggestion receives further support from consideration of the effects of the inward rotation of the lower part of the tympanic ring in many mammals. The ossiculum accessorium malleoli of some mammals (not discussed by Olson) also helps to confirm Olson's views. This small element lies medial or dorso-medial to the goniale, with which it often fuses, and medial also to the chorda tympani. Older investigators (see van Kampen[10]) speak of this bone lying *above* Meckel's cartilage, and it was regarded as the surangular by Watson[11]. Broom[12] and Forster Cooper[13] held the same view about a similar ossicle in *Chrysochloris* which, however, lies ventro-medial to Meckel's cartilage. The last-mentioned ossicle is almost certainly the prearticular; that of many Ungulates is probably the same, and may owe its position to rotation of the malleus and neighbouring lower jaw elements. This region deserves further investigation.

It is hoped to present a fuller account of this subject, with comments on recent work, in another place.

T. S. WESTOLL.

Department of Geology and Mineralogy,
University of Aberdeen. Oct. 20.

[1] Gaupp, E., *Arch. Anat. Physiol.*, I Teil (*Arch. Anat. Entw.-Gesch.*), Supp. Bd., 1 (1912).
[2] van der Klaauw, C. J., *Z. ges. Anat.*, I Teil (*Z. Anat. Entw.-Gesch.*), **69**, 32 (1923).
[3] Goodrich, E. S., "Studies on the Structure and Development of Vertebrates" (London, 1930).
[4] de Beer, G. R., "The Development of the Vertebrate Skull" (Oxford, 1937).
[5] van der Klaauw, C. J., *Ergebn. Anat. Entw.-Gesch.*, **25**, 565 (1924).
[6] Broom, R., *Phil. Trans.*, B, **226**, 1 (1936), esp. pp. 23–4, 27, figs. 102, 103, 121.
[7] Westoll, T. S., *Proc. Roy. Soc.*, B, **131**, 393 (1943).
[8] Olson, E. C., *Geol. Soc. Amer.*, Spec. Papers, No. 55 (1944).
[9] Findlay, G. H., *Proc. Zool. Soc. Lond.*, **114**, 91 (1944).
[10] van Kampen, P. N., *Morph. Jahrb.*, **34**, 321, 372 (1905).
[11] Watson, D. M. S., *Phil. Trans.*, B, **207**, 311, 361 (1916).
[12] Broom, R., *Proc. Zool. Soc.*, 449, 454, 457, pl. 2, fig. 9 (1916).
[13] Forster Cooper, C., *Phil. Trans.*, B, **216**, 265, 267, text-fig. 1 (1928).

## Control of Buried Viable Weed Seeds by Means of Boron

BORON compounds, when present in the soil in abnormal concentrations, are known to exert a highly toxic effect on the vegetation. The extent of the toxicity at given concentrations varies according to the component species present in the vegetation, and according to the nature and texture of the soil[1].

In the course of an investigation conducted at the Welsh Plant Breeding Station to study the growth of red clover on old grassland soils, it was revealed that an application of borax at the rate of 90 lb. per acre had an extremely toxic effect on the germination and establishment of the clover. The soil was a medium loam of average fertility, and had carried grass vegetation for many years. The soil samples were taken at a depth of 2–6 in. below the surface vegetation, and placed in wooden boxes 21 in. × 15 in. × 3 in. Each treatment was replicated twice.

As was expected, the control boxes showed that the soil contained a very large population of buried viable weed seeds (see table below), but where borax had been applied at the above rate, a practically weed-free surface was obtained. The few weeds that did appear in the treated boxes were largely confined to the corners and around the edges of the boxes, where the distribution of the borax had presumably not been quite uniform.

The accompanying table shows the germination and establishment of red clover (sown at the rate of 35 seeds per box) in the treated and untreated boxes. The establishment figures of viable weed seeds are also given.

| Seedlings | Germination | | Establishment | |
|---|---|---|---|---|
| | Treated | Untreated | Treated | Untreated |
| Clover | 10 | 29 | 7 | 28 |
| Weeds* | — | — | 15 | 137 |

* The establishment figures given bear no relation to total buried viable weed seed population, as they refer only to such seed as were sufficiently near the surface to give visible seedlings.

It was evident from the fact that the surface obtained in the treated boxes was practically free from weed and clover that the toxicity of the borax had effected a very heavy kill on both the clover and buried weed seeds prior to their becoming visible seedlings.

The duration of the toxicity due to boron was further investigated and the treated boxes were resown with red clover at the previous rate (35 seeds per box), 35 days from the application of the chemical. The germination was now even and vigorous, and 31 seeds out of 35 gave strong normal seedlings. The germination of weeds was very low—only 15 weed seedlings appeared, and that in spite of the fact that the soil had been completely overturned at re-sowing. This seems to indicate that the toxic effect had operated throughout the depth of the soil.

It is evident from these figures that the toxic effect had been practically removed after 35 days. No determination was made of the precise number of days after which germination gained normality. Further, as this experiment was conducted in boxes and under glass, it is not known whether the removal of toxicity would occur at the same rate under field conditions. Also it must be stated that the rate of application

is not suggested as optimum, and a higher or lower rate may be more efficacious.

The results given above were obtained as part of a more general investigation; a more detailed repetition of the section dealing with toxicity is intended, before precise practical application can be suggested. These results do, however, offer distinct possibilities of practical control for one of the most acute weed problems in agriculture.

WATKIN WILLIAMS.

Clover Breeding Department,
Welsh Plant Breeding Station,
Aberystwyth.
Oct. 20.

[1] See Robins, Crofts and Raynor, "Weed Control" (1942).

## Mechanism of the Milling Shrinkage of Wool Fabrics

THE work of Speakman[1] and his collaborators has indicated that the felting or milling shrinkage of wool fabrics is primarily due to the scaliness of the fibres, but that in cloths of similar construction and composition the magnitude of the effect is determined by the ease of extension and the power of recovery of the fibres. The shrinkage of fabrics milled under comparable conditions is greater in acid and alkaline solutions than in water, and cloths may be rendered unshrinkable by treatment with reagents such as chlorine[2], caustic soda[3] or sulphuryl chloride[4]. These phenomena may be due to modification of either elastic properties or scaliness, and the experiments described in this note were designed to determine which of the two characteristics was more affected. A complete account of the investigation will appear elsewhere, but its main features are as follows:

Measurements of the scaliness of wool fibres in acid (0·1 *N* hydrochloric acid), water, and 2 per cent borax solution (*p*H 9·24) were made by the violin bow method of Speakman and Stott[5], and the results are summarized in Table 1.

TABLE 1.

| Medium | Scaliness |
|---|---|
| 0·1 *N* hydrochloric acid .. .. | 29·4 |
| Water .. .. .. | 23·5 |
| 2 per cent borax solution .. .. | 21·5 |

The scaliness increases with decreasing *p*H, and hence scaliness changes act in unison with the reduced ease of extension to increase the rate of milling of fabrics in acid solutions. The reduced scaliness in alkaline solutions, however, acts in the opposite direction to the increased ease of extension, and the superior milling shrinkage in alkaline solutions of *p*H 9·24 must be due solely to increased ease of extension, which is not accompanied by a loss of power of recovery of the fibre.

The role of scaliness in determining the shrinking properties of wool fabrics has also been demonstrated by measuring the scaliness and elastic properties of wool fibres treated with a 0·2 *N* solution of chlorine in carbon tetrachloride for various times. Parallel experiments in which patterns of cloth were chlorinated under the same conditions, and then milled to measure their shrinkage, were also carried out. The results are shown in Table 2.

It is evident that the loss in milling shrinkage is mainly due to a reduced scaliness of the fibres, for there is little change in the elastic hysteresis, and the increased ease of extension would result in an increased shrinkage. Since cloths which have been chlorinated for two hours are completely unshrinkable when milled in acid or soap, it appears to be unnecessary to reduce the scaliness of the fibres to zero in order to realize unshrinkability. Similar results have also been obtained on cloths and fibres treated with other reagents which render wool cloths unshrinkable. Whereas the scaliness, as measured by the percentage difference in friction, is reduced by chlorination, the actual values of the angles of friction increase, indicating greater adhesion between the fibres and the surface over which they slip. This increased adhesion is reflected in the greater strength of chlorinated yarns, for since the strength of individual fibres falls on chlorination, the superior yarn strength must arise from an increased adhesion between the fibres.

TABLE 2.

| Time of treatment (hr.) | % shrinkage after milling for 30 min. | % reduction in work to stretch in: Water (i) | 0·1 *N* hydrochloric acid (ii) | 2% borax (ii) |
|---|---|---|---|---|
| 0·0 | 35·0 | 2·7 | 38·0 | 0·8 |
| 0·5 | 7·9 | 9·9 | 40·8 | 15·0 |
| 1·0 | 5·0 | 12·0 | 39·2 | 18·5 |
| 2·0 | 0·6 | 15·8 | 41·5 | 19·1 |
| 3·0 | −4·0 | — | — | — |
| 5·0 | — | 17·6 | 41·8 | 22·5 |

| % Elastic hysteresis in: Water | 0·1 *N* hydrochloric acid | 2% borax | (iii) Scaliness in: Air | Water | 0·1 *N* hydrochloric acid | 2% borax |
|---|---|---|---|---|---|---|
| 53·5 | 40·0 | 62·2 | 15·8 | 23·5 | 29·4 | 21·5 |
| 54·9 | 41·2 | 62·2 | 12·0 | 7·9 | 17·1 | 10·6 |
| 54·9 | 40·2 | 62·4 | 7·4 | 4·1 | 9·8 | 6·0 |
| 56·1 | 41·5 | 62·1 | 5·0 | 1·5 | 7·2 | 5·3 |
| — | — | — | — | — | — | — |
| 54·6 | 42·4 | 61·8 | 4·0 | 1·0 | 6·0 | 3·5 |

(i) Calculated as a percentage of the work required to stretch an untreated fibre in water.
(ii) Calculated as a percentage of the work required to stretch a chlorinated fibre in water.
(iii) Calculated as described by Speakman and Stott[5].

C. S. WHEWELL.
L. RIGELHAUPT.
A. SELIM.

Department of Textile Industries,
The University,
Leeds.

[1] *J. Text. Inst.*, **24**, 273T (1933).
[2] Brit. Pat. 417,719.
[3] Brit. Pat. 538,428; 538,396.
[4] Hall, *J. Soc. Dyers and Col.*, **55**, 389 (1939).
[5] *J. Text. Inst.*, **22**, 339T (1931).

## Halogenation in the Allyl Position

IN the last issue of the "Annual Reports of the Chemical Society"[1], F. S. Spring has directed special attention to the success of Ziegler and his collaborators[2] in substituting olefines in the α-methylene, or 'allyl position', by means of N-bromo-succinimide, and it has been claimed that this is a new reaction.

Whereas from the preparative aspect N-bromo-succinimide is obviously a valuable new reagent, halogen substitution in the α-methylene position to a double bond is but to be expected if the reaction is of the 'free radical' or 'atomic' type, as shown recently by E. H. Farmer and his colleagues[3].

The 'atomic' chlorination of *cyclo*-hexene to $\Delta^2$*cyclo*-hexenyl chloride by benzene diazonium chloride was reported by me in 1939 [4], and in 1937 I had suggested tentatively that compounds containing the so-called 'positive halogens', as, for example, the N-halogeno-imides, were molecules which underwent neutral or 'atomic' bond fission in preference to ionic bond fission[5]. The work of Ziegler should be regarded as a definite confirmation of this hypothesis.

Reaction mechanisms involving the neutral bond fission of 'positive halogen' compounds should, however, be applied with caution, since chemical changes of this type are in general chain processes very much dependent for their success on the concentrations and energy-levels of the transient radicals[6], and on the non-polar character of the solvent used. Thus Kharasch and Priestley[7] have reported the occurrence of two distinct types of addition reactions between N-halogeno-imides and olefines, and the regular use by Ziegler of carbon tetrachloride as solvent may well be an essential factor in contributing to the success of the $\alpha$-methylenic substitution[6].

W. A. WATERS.

University Science Laboratories,
Durham.
Oct. 26.

[1] "Annual Reports of the Chemical Society", **40**, 101 (1943).
[2] *Annalen der Chemie*, **551**, 80 (1942).
[3] *Trans. Faraday Soc.*, **38**, 340 (1942).
[4] *J. Chem. Soc.*, 1805 (1939).
[5] *J. Chem. Soc.*, 2007 (1937).
[6] Waters, *Trans. Faraday Soc.*, **37**, 770 (1941).
[7] *J. Amer. Chem. Soc.*, **61**, 3425 (1939).

## A Colour Reaction for Aromatic Amidines

Ekeley and Ronzio[1] have described a series of coloured compounds which are obtained when aromatic amidines are heated with glyoxal in alkaline solution. The reaction is complex, and the results are uncertain and dependent on the conditions employed. By heating with a very small amount of glyoxal at *p*H 9 in the presence of a borate buffer, the reaction is made much more sensitive and reliable, and is suitable for the quantitative estimation of amidines down to 1 in 100,000[2]. The buffer is made up from 4 gm. of boric acid neutralized in hot solution with caustic soda to *p*H 9, and diluted to 100 ml. The glyoxal reagent is a 0·5 per cent aqueous solution of glyoxal sodium bisulphite.

To a few millilitres of the suspected amidine solution (containing a few milligrams of amidine and roughly neutralized if necessary) is added about a millilitre each of buffer and glyoxal reagent, and the mixture is heated almost to boiling for a few minutes, or for ten minutes in a boiling water bath. A pink or magenta colour appears, which usually becomes redder in acid and bluer in alkaline solution. Maximum colour is obtained with about two molecules to one of amidine, and excess of glyoxal inhibits the reaction.

The reaction appears to be sharply specific for an unsubstituted aromatic amidine group. It is given by C-substituted benzamidines, naphthalene diamidine and nicotinamidine. Nearly fifty aromatic amidines have been tested and found to give the reaction. It is not given by aromatic amidines with one or two methyl groups on the nitrogen atoms of the amidine group. Benzamidrazone and phenyl acetamidine give a pale yellow colour. Guanidines, biguanides, amines or aliphatic amidines do not react.

The reaction products from some aromatic amidines fluoresce in ultra-violet light down to dilutions of 1 in 100 millions. Those from the diamidine series (for example, propamidine) are sparingly soluble, show no colour change with variation of *p*H, and do not fluoresce.

When the method had been in use for some time, Devine[3] published a process of estimation using the brown colour produced when an amidine is heated with a large excess of glyoxal in strong caustic soda. This has the disadvantages that the glyoxal reagent is unstable and must be made up daily; that the conditions of heating are difficult to reproduce exactly; and that the colour is unstable and must be estimated immediately. It is, however, not so sensitive to variations in the amount of glyoxal used as is the present method.

I wish to thank Dr. H. King and Dr. J. Walker for supplying the compounds.

A. T. FULLER.

National Institute for Medical Research,
Hampstead,
London, N.W.3.
Oct. 20.

[1] Ekeley, J. B., and Ronzio, A. R., *J. Amer. Chem. Soc.*, **57**, 1353 (1935).
[2] Evans, D. G., Fuller, A. T., and Walker, J., *Lancet*, ii, 523 (1944).
[3] Devine, J., *Ann. Trop. Med. and Parasitol.*, **38**, 35 (1944).

## David Forbes and Guano Archæology

IN a footnote to a brief communication made by Virchow in 1873[1] is a statement transmitted to him through Jagor and A. W. Franks, which seems to imply that David Forbes, the well-known geologist, owned or knew of wooden statuettes taken from the guano deposits of the Peruvian coast, depicting a man being bitten in the penis by a snake. This *motif* is known on certain Mochica ceramics[2], but otherwise appears to be absent from Peruvian iconography.

We are engaged in the collection of all available data on the archæology of the now exhausted Peruvian guano deposits. The available information strongly indicates that important chronological and climatological results may be expected from this neglected field. We are therefore anxious to trace any further references to the material known to Forbes, as no published figure of an object from the guano, exemplifying the *motif* in question, is known to us. If the objects could be identified and were accompanied by indications of locality and depth, they would probably provide an important addition to the very restricted series of authenticated finds of early Peruvian cultures in guano. David Forbes is known to have made extensive mineralogical, geological and ethnographic collections; but the fate of these and of his extensive manuscript notes, not mentioned in his will, are unknown to us. We should be most grateful for any information that would lead to the discovery of this or of any other guano finds.

GEORGE A. KUBLER.
G. E. HUTCHINSON.

Yale University,
New Haven, Conn.

[1] *Verhandl. Berliner Ges. f. Anthropol. Ethnol. u. Urgeschichte*, 154 (1873) in *Z. Ethnol.*, **5** (1873).
[2] For example, "Cerámicas del antiguo Perú, coll. Wassermann-San Blas", privately printed (Buenos Aires, 1938), 272–73, Figs. 471, 742.

# MEDICAL STUDIES IN BRITAIN

FROM time to time the *British Medical Bulletin* publishes articles by experts on the development of medical studies in Britain. The first of these, on the development of ophthalmology (*Brit. Med. Bull.*, 1, 100; 1943), was noticed in *Nature* (153, 383, March 25, 1944). The second, third and fourth have now appeared (*Brit. Med. Bull.*, 2, Nos. 5–6; 1944). The second is on the genetic aspect of disease, by Dr. Julia Bell; the third is on obstetrics, by Prof. James Young, of the British Postgraduate Medical School, London; the fourth is on oto-laryngology, by Dr. Douglas Guthrie.

Dr. Bell, beginning with a quotation from Hippocrates (400 B.C.) on the hereditary origin of epilepsy, briefly outlines the subsequent history of ideas on the hereditary nature of some diseases. What she tells us of Karl Pearson is interesting because she was his assistant during 1908–14. Her discussion of modern genetics is a valuable summary in the short space available of a complex subject. Fundamental features of this third period of her survey have been the conception of the gene and its localization in the chromosome, and the study of linkage. Work of this kind has, she says, a limited application to hereditary disease in man, but notable work has been done on colour blindness and hæmophilia. The work on blood groups has been among the most important of the single discoveries made. Dr. G. L. Taylor, Dr. R. R. Race and Dr. W. T. J. Morgan have explained this work in an issue of the journal which is devoted to the blood and some of its disorders (*Brit. Med. Bull.*, 2, Nos. 8–9; 1944). The collection of the pedigrees of disease continues, says Dr. Bell, and there can be few in Great Britain who are better qualified than she is to discuss this method of investigation. She also discusses genetic work on cancer and leukæmia. If it is not possible, she says, to stay the onset or course of disease or of a defect which is genetically determined, preventive measures, such as the discouragement of consanguineous marriages or voluntary sterilization of possible transmitters of such diseases, have been considered. Dr. Bell concludes that little is to be expected from the former method, and that the latter may be very wasteful. There is, she thinks, great promise in the work now being done in experimental genetics and embryology, but the results obtained by the study of relatively primitive organisms should be applied to the human species with caution. The selected bibliography which she gives is valuable.

Prof. James Young traces British midwifery back to the reign of Henry VIII, when, in 1540, the first British text-book on the subject appeared—a translation of Rösslin's book published in Hagenau in 1513. Little progress was made during the sixteenth and seventeenth centuries, when practitioners of midwifery were mostly the ignorant and illiterate midwives who called in the doctor "with his destructive instruments" in emergencies. But Paré, in France in 1550, discovered the value of podalic version, and from this Prof. Young dates the rise of modern obstetrics. Obstetric forceps, "one of the greatest and most beneficent of all obstetric discoveries", were invented about 1630–34, but they remained a close secret of the English Chamberlen family for more than a century. Their use did not become general until Chapman first described them in 1713. It was William Harvey who introduced a new intellectual spirit into the study of obstetrics, but he strangely failed to realize the truth taught by his teacher Fabricius that the child is born by the muscular action of the womb, insisting that it "attacks the portals of the womb" and gets out by its own efforts. Harvey and others, including the Chamberlen family, made improvements in the status and instruction of midwives, and some control of them was instituted.

Harvey and his friends emphasized that labour was a natural physiological process and did not favour interference until it was clear that it was necessary; and this idea dominated the British school of obstetrics throughout the eighteenth century. By the middle of this century the British school had made such progress that it led the world. The genius of William Smellie (1697–1763) earned for him the description as "one of the most important obstetricians of all times and all countries". Prof. Young gives an interesting description of the fight between the men and women midwives. It is only recently that the British midwife has been given by the Midwives Act of 1902 and subsequent legislation "a position of prime importance in the maternity organization of the country". With the nineteenth century came anæsthesia, antiseptic and later aseptic surgery, and the story of the control of puerperal sepsis, the contagious nature of which was suspected by Gordon in Aberdeen in 1795 and independently in 1843 by Oliver Wendell Holmes in America and by Semmelweiss in Vienna. The fact that a streptococcus was the cause was demonstrated by Pasteur in 1867. British bacteriologists have played a notable part in the prevention of obstetric contagion.

The rest of this interesting article deals with the history and present position of preventive aspects of obstetrics and with the recognition of obstetrics as a special branch of medicine. "Gynæcology," says Prof. Young, "is a creation of the nineteenth century." It dates from the work of Virchow and the creation of the microscope. In the same issue of the *British Medical Bulletin*, Dr. W. C. W. Nixon writes on nutrition and pregnancy and lactation, and there are valuable reviews of selected papers on subjects of obstetrical and gynæcological interest.

Dr. Douglas Guthrie's article on oto-laryngology takes us back to Fallopius, whose name is familiar to every first-year student of biology. Fallopius wrote in 1564 what was probably the first complete book on the ear. It was not until 1748 that Duverney, of Paris, demonstrated that the Eustachian tube was not a means of breathing or hearing, but simply a means of renewing the air in the tympanum. Willis, of Oxford, also known to students of biology and medicine as the discoverer of the 'circle of Willis' and other features of the nervous system, published in 1683 his treatise entitled "Two Discourses concerning the Soul of Brutes", in which he gave an account of the phenomenon of hearing better in a noise (paracusis Willisi) and told of a woman who, though she was deaf, could hear every word perfectly so long as a drum was beaten in her room; her husband kept a drummer so that he could talk to her.

During the eighteenth century two of the most important instruments used in oto-laryngology were invented, both by laymen. Guyot, a postmaster of Versailles, produced in 1724 a form of the Eustachian catheter, which he introduced through his own mouth in order to syringe his ear and so relieve his deafness. In 1854 the Parisian singing master and singer, Manuel Garcia, invented the laryngoscope in order to see the action of his own vocal chords. But

in the eighteenth century oto-laryngology was chiefly concerned with diphtheria, which was very prevalent and fatal then. The first hospital in the world to be devoted to diseases of the ear, the Royal Ear Hospital, was founded in 1816 by J. H. Curtis, an unqualified man who had a large practice in London. The subsequent history of oto-laryngology brings us to Joseph Toynbee (1815–60), the father of Arnold Toynbee, James Hinton (1822–75), also remembered as a philosopher, and Sir William Wilde, of Dublin (1815–76), the father of Oscar Wilde. Toynbee's beautiful dissections were preserved in the Museum of the Royal College of Surgeons until they were destroyed by enemy action in 1941.

Laryngology became a special branch of medicine in the middle of the nineteenth century and Sir Morell Mackenzie was the founder of modern laryngology. Another great laryngologist was Sir Felix Semon, a German pupil of Mackenzie's who settled in London. Semon was one of the last to practise laryngology before it became merged with otology. Nowadays developments in bronchoscopy and oesophagoscopy are extending the boundaries of the science of oto-laryngology; and speech and voice disorders offer a further field.

Dr. C. S. Hallpike, in another article in this issue of the *British Medical Bulletin*, discusses research in otology and Dr. E. H. Broome discusses the scope of speech therapy. Dr. Guthrie provides a second article, on "Pioneers in the Teaching of the Deaf". A discussion on the audibility of the radio voice at a meeting of the Royal Society of Medicine will interest lay readers who are habitual radio listeners. It is evident that the radio speaker has to deal with a complex problem. Mr. John Snagge said in this discussion that it is impossible to tell from gramophone records whether a speaker will be a success at the microphone, and also that the construction or lining of the walls of a room in which a broadcaster speaks has little effect on the reception of his voice by the distant listener. The quality of the voice is often more important than the speed of the speech.

Peripheral vascular disorders are the subject of a valuable article by Prof. J. R. Learmonth (*Brit. Med. Bull.*, 2, No. 7; 1944). This issue is devoted to the peripheral blood vessels and deals with arterial spasm, arterial injuries and injuries due to low temperature, such as frostbite. Fifteen photographs illustrate the article on the pathology of immersion foot. The study of these conditions is always an important one, but it is perhaps even more important in these times of war and air-raid casualties. G. LAPAGE.

## DECIDUOUS CYPRESS
## (*Taxodium distichum*)

By ALEXANDER L. HOWARD

THIS beautiful tree, the only cypress which sheds its leaves in the winter, is far too little known and appreciated by those who possess it. In spring its light-coloured feathery leaves fall gracefully from the pyramidal shape of the tree; in summer the full effect of the foliage is different from anything else in the landscape; in autumn it reaches perfection, when the sprays turn a golden hue, almost reminiscent of a set piece in a firework display; and in winter its curious habit of growth attracts the eye, because of its weird, almost ghostly appearance.

It is known in the United States by the names of bald cypress, swamp cypress and Louisiana cypress, and according to Sargent "rarely 12 feet and generally 4–5 feet in diameter above the abruptly enlarged strongly buttressed usually hollow base", occasionally 150 ft. high, but in Great Britain the maximum height and girth recorded is 110 ft. by more than 12 ft.

It is to be found sparsely distributed over a wide area, generally by the banks of streams, rivers or lakes. While it can be reared apart from such positions, it is essentially a tree dependent upon water-ways. Introduced from other countries, it has both suffered and benefited by the fashion of the day. For the last half-century it has been almost forgotten, while in the beginning of the nineteenth century it was extensively planted, and a number of these trees are still flourishing to-day, but inquiries I have made seem to show that few, or perhaps scarcely any, have been planted during the last half-century. Interesting accounts of many fine examples are catalogued by Elwes. He mentions:

"The trees at Syon [have been frequently described and figured. They are planted in damp soil by the side of a sheet of water, and one of them has produced knees of 1 to 2 feet high. This tree . . . measured in 1903 90 feet by 12, but there is a much taller one on the other side of the water, which when we saw it last, in 1905, was 110 ft. high, and is the tallest we know of in Europe. Another, in the Duke's Walk, is 85 feet by 10 feet 3 inches."

In October 1944 I visited Syon and the trees were in perfect health. I was doubtful which one Elwes found to be 90 ft. by 12 ft., but I measured the largest, which exactly answered his description of site, and found it to be 21 ft. around the base. The knees rising to 2 ft. and a little more range around the tree on three sides—on the south side to 52 ft., on the west side to 46 ft., and on the north side to more than 40 ft. There is also on the other side of the walk a very handsome young tree about 80–90 ft. high and 12 ft. girth at the base.

Elwes also reports:

"At White Knights, Reading, there are several trees, but none of large size, the biggest measuring, in 1904, 67 feet by 7 ft. 10 inches. They are remarkable, however, for variety of habit. One is a tall narrow tree with upright branches, almost fastigiate. In another tree the stem is twisted, as often occurs in the chestnut, and most of the branches are twisted also in the direction against the sun. Loudon mentions these as young trees of peculiar habits."

Mr. F. G. Franklin, at White Knights, writes to me under date of October 7, 1944, as follows: "the trees you mention are still alive but I could not say they are very much larger than you say."

And further:

"At Strathfieldsaye there is a tree, mentioned by Loudon as being 46 feet in height by 3 ft. 4 in. in diameter, which I found in 1903 to be 63 ft. high by 9 ft. in girth (I have a letter from the Duke of Wellington in October 1944, in which he informs me this is now 69 ft. and the girth 11 ft. 6 in. at 5 ft.) It is growing in stiff clay soil and has no knees: the stem is deeply furrowed.

"At Coombe Abbey, Warwickshire, Mr. W. Miller reports that a tree, mentioned by Loudon as 47 ft. by 2 ft. 3 in. (diameter e.d.) in 1843, had attained, in 1887, 75 ft. by 11 ft. 6 in. at 3 ft. from the ground. [In answer to an inquiry I am told by Mr. J. G. Gray there has been no such tree there for the past 22 years.]

"At Brockett's Park, near Hatfield, there are many trees planted along a walk on the banks of the Lee, and

forming an irregular line in which the trees vary very much in size. In the sheltered part of the valley, where the soil and situation are very favourable, they average 70–80 ft. high, the best I measured being 80 ft. by 10 ft. and 86 ft. by 9 ft. But lower down the stream, where the valley is more exposed to the wind, they are stunted, and not more than half the height of those above. There are knees on some of the trees overgrown with moss and meadowsweet, but not so large as those at Syon."

I saw these trees in the autumn of 1943 and found them generally in good health, but some damaged by tempest.

In the courtyard of Dartington Hall, near Totnes, a very fine tree flourishes, and this was shown to me by Mr. Elmhurst a few years before the War. When I expressed surprise that this great tree stood alone in good health in an exposed position on the hill, he explained that its roots were in a large disused well. A similar tree is in good health to-day at the Grand Hotel, Lyndhurst, perhaps 70–80 ft. high, where it also is said to have its roots in a disused well. A fine tree about 70–80 ft. high and more than 2 ft. 6 in. in diameter grew by the side of the stream a little north of Hunton Bridge, near Watford, Herts. This may have been the tree which Elwes figures as being, when he measured it, 85 ft. by 14 ft. in 1884. At the request of the owner, about twenty years ago, I had it cut down: reference to the wood will be made later, but I heard a few years after that my brother had known the tree and had landed many good trout under its branches. The two dates of fashionable planting appear to be during 1720–62 and in 1843, and choosing between these without further information, I think this tree must have belonged to the earlier date. Inquiries over twenty years gave disappointing results, as few trees could be found of later planting. Some good specimens can be seen at the Pinetum at Bedgebury. Mr. W. Dallimore writes me under date of October 11, 1944, as follows:

"The Taxodiums at Kew are, I imagine, from 75 to 80 years old, although I cannot be certain on the point. The Taxodiums at Bedgebury are all quite young. Some were planted in 1926, others in 1927, and they were 3 to 4 years old when planted."

The varying habit of growth is characteristic of the tree in the United States, and it is the same in Great Britain. This feature is noticeable when the limbs are bare, and this ghostly appearance, previously referred to, stands out against the winter sky.

The wood is of great value, and so far much too little appreciated in Britain. Quoting from "Timbers of the World":

"It is imported in the form of planks and boards of various qualities, but only of late years in any considerable quantity. It is yellowish-red, often nearly salmon coloured. In the United States it is used so extensively that Gibson writes 'the uses are so nearly universal that a list is impossible'. Another American authority, Hough, says: 'Its great durability, immunity from the attack of parasites, and non-liability to great shrinking or warping makes it one of our most valuable woods for all woodwork exposed to weather, for tank construction, cooperage, etc.'. These qualities combined with a sharp segregation of the hard and soft grain, and with a scantiness of resin, should bring this wood into more general use. It is especially satisfactory for out-houses and green-houses, and where so used will probably outlast any other kind of softwood, even when unpainted. One such unpainted building in this country has survived for six years (1920), and the wood, though subject to continual heat and moisture, is quite sound throughout. [Inquiry to-day (1944) shows that the woodwork in the orchid-houses referred to is in perfect condition, without showing any sign of decay.] The English grown wood appears to possess equally good qualities, and where available should be used for exposed woodwork. It differs from the American grown timber that reaches this country in colour, which is light yellow, and in appearance it recalls Lebanon cedar. . . ."

Gibson has made a statement which suggests that the remarkable durability of this wood is somewhat doubtful, but there is reason to question his opinion. Prof. C. S. Sargent, in a private letter (March 3, 1915) on this subject, says:

"The wood (*Taxodium distichum*) is considered to be exceedingly durable, and I do not know on what authority Gibson has made his statement. It is not impossible, of course, that the wood of a diseased tree, or one that had grown under abnormal conditions, might be of poor quality."

A very large quantity was purchased by the British Government during the War for aeronautical construction, but it was found to be unsuitable, and led to deplorable results.

Its great durability renders it most valuable, but the foregoing is an illustration of the undesirability of accepting a timber based upon mechanical experiments, and lends a strong argument in favour of following the advice of the unprejudiced craftsman.

This tree, not indigenous to Great Britain, should be planted wherever possible, for its great beauty and utility: it must be borne in mind, however, that in its native habitat it grows in close proximity to streams or abundant water supply.

## NORTH AMERICAN ARCHÆOLOGY AND CULTURES

BULLETIN 133 of the Bureau of American Ethnology (Washington, D.C.: Gov. Printing Office. 1 dollar) includes seven Anthropological Papers (Nos. 19–26) of varying importance, dealing with the American Indians and their cultures.

Dr. P. Drucker contributes a useful survey of northern North-West Coast archæology, which, in contrast to the ethnology of the region, has been much neglected. The paper is based on his own field-work on a number of middens in the country occupied by the coast Tsimshian and Kwakiutl in historic times, supplemented by a summary of previous publications and museum collections. No marked difference is apparent between the cultures excavated and those of the recent tribes, but Dr. Drucker believes that some kind of culture sequence will yet be found, on the analogy of neighbouring areas. Finally, it is suggested that both archæological and recent cultures of the northern North-West Coast fall into three main geographical divisions, described as the northern (Tlingit-Haida-Tsimshian), the Milbanke-Queen Charlotte Sound (Kwakiutl), and the Straits of Georgia-Puget Sound aspects.

A large part of the volume is occupied by a study of the Eastern Cherokees of North Carolina by W. H. Gilbert, jun., based on two years of research which included a four-months sojourn among them. A survey of the culture of this remnant is followed by a description of the state of the tribe in former times, culled very largely from MS. data collected by J. H. Payne in the first half of the nineteenth century. Comparison between the two periods shows not only

the inevitable impoverishment of culture caused by contact with the white man, but also certain fundamental changes. The social organization of the older society, with its white and red officials for peace and war, conforms in general with that of other south-eastern tribes. The surviving remnant has lost this dual division, and has developed other features of which the most striking is a system of preferential mating; this has become linked with the matrilineal clans to which most members of the tribe still belong. The essence of this is that a person is expected to marry into one of his grandfathers' clans, but not into those of his parents, a state of affairs which was happily expressed by an Indian informant who said, "The Cherokees marry their grandmothers!" This system is unparalleled anywhere outside Australia, and its appearance is used to point the moral that a study of the historical antecedents of a tribe will not necessarily throw light on its present-day organization. A feature of this paper is a series of elaborate family-tree diagrams.

Another paper on the social and religious life of a dying Indian society deals with the Carrier Indians of the Bulkley River basin in British Columbia. It is contributed by D. Jenness, who spent about four months among them. A good account is given of the political organization, including the part played by clan and personal crests, and there is a brief summary of the life-cycle. The section on religion includes an interesting account of some hybrids formed by the impact of Christianity on the old beliefs, and the importance of dreams in the religious life of the people is stressed. The remarkable lack of historical sense among these people is shown in the impossible stories which they weave around events scarcely a generation old. The paper ends with an account of the medicine men, which includes a remarkable first-hand description of a ceremony for the cure of 'kyan sickness', a kind of hysteria involving cannibalistic cravings, to which these Indians seem particularly susceptible.

A paper by Robert F. Heizer on "Aconite Poison Whaling in Asia and America" gives a survey of whaling along the North Pacific coasts from Japan to Vancouver Island, which shows that three basic methods were practised. Netting is found mainly in Japan, the harpoon-line-float method is practised by the Eskimo and Chukchee in the Far North and is also found in the Vancouver – West Washington area, and spearing with a lance dipped in aconite poison predominates in the intermediate regions of both Asia and America. It is concluded that the poisoning method was used first by the Ainu and by the Kamchadal of Kamchatka, whence it is conjectured that it spread to the Aleutian Islands and the neighbouring part of the mainland of Alaska. It is probable that the movement was in this direction, but a word of caution is necessary since the link between the two areas is weak at its western end, because evidence for the ancient occupation of the Commander Islands is lacking.

In "The Quipu and Peruvian Civilization", John R. Swanton, arguing from quotations from the chroniclers, concludes that the quipu was used as a more extensive method of expression than the mere recording of numbers. From analogy with other high civilizations, he considers that Andean culture must have had such a mode of expression—a singularly unconvincing argument. It is suggested that the most highly developed quipus are likely to have been in public repositories which the Spaniards destroyed.

G. H. S. BUSHNELL.

# FORTHCOMING EVENTS

## Saturday, December 16

PATHOLOGICAL SOCIETY OF GREAT BRITAIN AND IRELAND (joint meeting with the BIOCHEMICAL SOCIETY) (at the Royal Society of Medicine, 1 Wimpole Street, London, W.1), at 11 a.m.—Discussion on "Cancer".

NORTH OF ENGLAND INSTITUTE OF MINING AND MECHANICAL ENGINEERS (at Neville Hall, Newcastle-upon-Tyne), at 2.30 p.m.—Mr. D. MacFarlane: "Mine Ventilation with reference to Fan Types and their Application".

QUEKETT MICROSCOPICAL SOCIETY (at the Royal Society, Burlington House, Piccadilly, London, W.1), at 2.30 p.m.—Dr. W. S. Bristowe: "In Quest of Spiders".

## Monday, December 18

ROYAL GEOGRAPHICAL SOCIETY (at Kensington Gore, South Kensington, London, S.W.7), at 8 p.m.—Mr. and Mrs. Harold Ingrams: "Hadhramaut in Time of War".

## Tuesday, December 19

ROYAL ANTHROPOLOGICAL INSTITUTE (at 21 Bedford Square, London, W.C.1), at 1.30 p.m.—Dr. O. Samson: "The Place of China in an Ethnographical Museum".

ROYAL SOCIETY OF ARTS (DOMINIONS AND COLONIES SECTION) (at John Adam Street, Adelphi, London, W.C.2), at 1.45 p.m.—Dr. I. E. Coop and Mr. A. L. Poole: "Scientific Collaboration between the United Kingdom and New Zealand in War and Peace".

EUGENICS SOCIETY (at the Royal Society, Burlington House, Piccadilly, London, W.1), at 5 p.m.—Discussion on "Aspects of the Housing Problem" (to be opened by Mr. Alexander Block).

ROYAL INSTITUTION (at 21 Albemarle Street, Piccadilly, London, W.1), at 5.15 p.m.—Sir Henry Dale, O.M., G.B.E., Pres.R.S.: "Modern Developments in Chemical Therapeutics", (iii) "Penicillin and Antibiotics".

INSTITUTION OF ELECTRICAL ENGINEERS (RADIO SECTION) (at Savoy Place, Victoria Embankment, London, W.C.2), at 5.30 p.m.—Discussion on "The Television-Receiver Sound Channel" (to be opened by Mr. D. C. Espley).

## Wednesday, December 20

ROYAL SOCIETY OF MEDICINE (at 1 Wimpole Street, London, W.1) at 2 p.m.—Discussion on "The Principles and Relationships Involved in Medical and Veterinary Education" (to be opened by Sir Henry Dale, G.B.E., O.M., P.R.S., Prof. J. B. Buxton and Prof. G. W. Pickering); at 4.30 p.m.—Dr. J. D. Rolleston: "The Folk-lore of Toothache" (C. E. Wallis Lecture).

INSTITUTION OF ELECTRICAL ENGINEERS (LONDON STUDENTS' SECTION) (at Savoy Place, Victoria Embankment, London, W.C.2), at 7 p.m.—Mr. J. F. Stirling: "The Condensation of Atmospheric Moisture on Insulation Surfaces".

## Friday, December 22

NORTH-EAST COAST INSTITUTION OF ENGINEERS AND SHIPBUILDERS (in the Lecture Theatre of the Literary and Philosophical Society, Newcastle-upon-Tyne), at 6 p.m.—Dr. H. Orenstein: "Methods and Motion Study Applied to the Shipbuilding Industry".

# APPOINTMENTS VACANT

APPLICATIONS are invited for the following appointments on or before the dates mentioned:

GRADUATE MASTER to teach GENERAL SCIENCE in the Junior School, mainly to Engineering and Building forms—The Clerk to the Governors, Mid-Essex Technical College and School of Art, Chelmsford (December 21).

SENIOR TECHNICIAN to take charge of Physics Workshop—The Secretary, Mount Vernon Hospital and the Radium Institute, Northwood, Middx. (December 22).

RESEARCH ASSISTANT with good constructional ability to assist in development of electro-optical apparatus—The Secretary, Mount Vernon Hospital and the Radium Institute, Northwood, Middx. (December 22).

PRINCIPAL OF THE SUNDERLAND TECHNICAL COLLEGE—The Director of Education, Education Offices, 15 John Street, Sunderland (endorsed 'Technical College—Appointment of Principal') (December 23).

ANIMAL HUSBANDRY OFFICER—The Secretary, Norfolk War Agricultural Executive Committee, Sprowston, Norwich (December 23).

IRRIGATION ENGINEER by the Government of Trinidad—The Ministry of Labour and National Service, Central (T. and S.) Register, Room 5/17, Sardinia Street, Kingsway, London, W.C.2 (quoting Reference No. E.1245A.) (December 27).

ASSISTANT ENGINEER by the City Council of Gibraltar—The Ministry of Labour and National Service, Central (T. and S.) Register, Room 5/17, Sardinia Street, Kingsway, London, W.C.2 (quoting Reference No. E.1244A.) (December 27).

PHYSICAL RESEARCH METALLURGIST for mechanical and physical investigations (Reference No. F.3202.XA), a RESEARCH METALLURGIST for investigations of foundry methods (Reference No. F.3201.XA), and a PHYSICAL CHEMIST for the investigation of corrosion problems, etc. (Reference No. F.3203.XA), in the Research Department of a South Wales Company—The Ministry of Labour and National Service, Central (T. and S.) Register, Room 5/17, Sardinia Street, Kingsway, London, W.C.2 (December 27).

RESEARCH MANAGER-PHYSICIST (with sufficient experience and theoretical knowledge of vacuum technique and associated equipment to take charge of development research for high-vacuum equipment) by a small but progressive and established concern located in S.E. London—The Ministry of Labour and National Service, Central (T. and S.) Register, Room 5/17, Sardinia Street, Kingsway, London, W.C.2 (quoting Reference No. A.735.XA) (December 27).

ASSISTANT TO THE ADVISER IN MYCOLOGY for the Western Province under the scheme of the Ministry of Agriculture and Fisheries—The Principal, Department of Agriculture and Horticulture, Long Ashton, Bristol (December 28).

AGRICULTURAL TRAINING OFFICER to organize the training in Agriculture and Horticulture of men and women released from War Service—The Executive Officer, Kent War Agricultural Executive Committee, County Hall, Maidstone (December 30).

DEPUTY CITY ELECTRICAL ENGINEER AND MANAGER—The Electrical Engineer, Electricity Works, Peterborough (endorsed 'Application for Deputy Electrical Engineer') (December 30).

ASSISTANT TO THE ADVISORY CHEMIST, Department of Agriculture—The Secretary, School of Agriculture, Cambridge (December 30).

ORGANIC CHEMIST on the staff of the Council for Scientific and Industrial Research, Division of Industrial Chemistry—The Secretary, Australian Scientific Research Liaison Office, Australia House, Strand, London, W.C.2 (December 31).

LECTURER (full-time) IN ENGINEERING in the Ashington Mining School—The Director of Education, County Hall, Newcastle-upon-Tyne 1 (December 31).

SENIOR LECTURER IN AGRICULTURE, and a BURSAR—The Clerk to the Governors, Royal Agricultural College, 7 Dollar Street, Cirencester (January 1).

TECHNICAL ASSISTANT IN THE HULL ELECTRICITY DEPARTMENT—The General Manager, Electricity Offices, Ferensway, Hull (January 1).

INSPECTOR OF AGRICULTURE, Sudan Government—The Ministry of Labour and National Service, Central (T. and S.) Register, Room 5/17, Sardinia Street, Kingsway, London, W.C.2 (quoting Reference No. F.3285.A) (January 2).

CHIEF ENGINEER of a large factory in Lancashire which, though not making machinery itself, uses a wide variety of machinery in its own processes—The Ministry of Labour and National Service, Central (T. and S.) Register, Room 5/17, Sardinia Street, Kingsway, London, W.C.2 (quoting Reference No. C.2384.XA) (January 8).

SENIOR PROFESSIONAL OFFICER (temporary), Industrial Diamond Research, University of the Witwatersrand, Johannesburg—The Secretary, Universities' Bureau of the British Empire, c/o University College, Gower Street, London, W.C.1 (January 15).

ASSISTANT LECTURER (Grade III) IN THE DEPARTMENT OF ZOOLOGY—The Registrar, The University, Liverpool (January 20).

ASSISTANT IN THE DEPARTMENT OF ZOOLOGY—The Registrar, The University, Liverpool (January 20).

CHAIRS OF POLITICAL ECONOMY AND ENGINEERING—The Secretary, The University, Aberdeen (March 31).

LECTURER IN GEOGRAPHY—The Secretary, The University, Aberdeen (March 31).

JUNIOR LECTURESHIP IN CHEMISTRY—The Secretary, Queen's University, Belfast (April 30).

TEACHER (man or woman) qualified to teach SCIENCE and MATHEMATICS in the Junior Technical and Day Continuation School—The Organizer of Further Education in Rugby, College of Technology and Arts, Eastlands, Rugby.

LECTURER (full-time, man or woman, temporary) IN BIOLOGY in the Leeds College of Technology—The Director of Education, Education Offices, Leeds 1.

ASSISTANT MASTER to teach MECHANICAL ENGINEERING Subjects—The Principal, Technical College, Wolverton, Bucks.

GRADUATE TEACHER (full-time) OF ENGINEERING for Day and Evening Classes in the Crewe Technical College—The Director of Education, County Education Offices, City Road, Chester.

ELECTRICAL OR MECHANICAL ENGINEER (Graduate or with equivalent qualifications) to teach ENGINEERING DRAWING, ENGINEERING SCIENCE, or MATHEMATICS, in the Maidstone Technical Institute—The District Secretary, Kent Education Committee, 13 Tonbridge Road, Maidstone.

GRADUATE LECTURER IN MECHANICAL ENGINEERING, mainly for Junior Day Work with some Senior Full-time or Part-time Day and Evening Classes in the Southend Municipal College—The Chief Education Officer, Education Office, Warrior Square, Southend-on-Sea.

---

# REPORTS and other PUBLICATIONS

*(not included in the monthly Books Supplement)*

## Great Britain and Ireland

Annotated Equilibrium Diagram Series. No. 2: The Equilibrium Diagram of the System Copper—Tin. By Dr. G. V. Raynor. Pp. 6. 6*d*. No. 3: The Equilibrium Diagram of the System Copper—Zinc. By Dr. G. V. Raynor. Pp. 6. 6*d*. No. 4: The Equilibrium Diagram of the System Copper—Aluminium. By Dr. G. V. Raynor. Pp. 6. 6*d*. (London: Institute of Metals.) [1710

Tory Reform Committee. Bulletin No. 7: The Control of Land Use. Pp. 16. (London: Tory Reform Committee.) [1910

Department of Scientific and Industrial Research: Forest Products Research Laboratory. Leaflet No. 34: The Identification of Timbers. Pp. 10. Leaflet No. 35: The Construction and Operation of Charcoal Kilns. Pp. 12. Leaflet No. 36: Some Observations on Timber-Drying Kilns and their Proper Use. Pp. 6. Leaflet No. 37: Selecting Ash by Inspection. Pp. 6. Leaflet No. 38: Termite-proofing of Timber for Use in the Tropics. Pp. 6. (Princes Risborough: Forest Products Research Laboratory.) [1910

Ministry of Fuel and Power. Twenty-second Annual Report of the Safety in Mines Research Board, 1943. Pp. 30. (London: H.M. Stationery Office.) 1*s*. net. [2310

Ministry of Agriculture and Fisheries. Bulletin No. 128: Wireworms and Food Production; a Wireworm Survey of England and Wales, 1939–1942. (Report from the Advisory Entomologists' Conference.) Pp. 62. (London: H.M. Stationery Office.) 1*s*. net. [2310

Agricultural Research Institute of Northern Ireland. Seventeenth Annual Report, 1943–44. Pp. 36. (Hillsborough: Agricultural Research Institute of Northern Ireland.) [2410

Dust Diseases: their Cause and Care. Pp. 16. Learning to Live: a Word of Encouragement for the Patient. Pp. 24. (London: National Association for the Prevention of Tuberculosis.) Specimen copies, free; 10*s*. per 100. [2510

Proceedings of the Royal Irish Academy. Vol. 50, Section A, No. 1: Remarks on the Self-Energy Problem. By W. Heitler. Pp. 6. n.p. Vol. 50, Section A, No. 2: A Note on the Evaluation of the Schrödinger Hydrogenic Intensity Integral. By T. S. Wheeler. Pp. 7–12. n.p. Vol. 50, Section A, No. 3: A Convenient Method of Measuring the Intensity of Nuclear Scattering of Fast $\beta$-Particles in a Cloud Chamber. By C. O. Ceallaigh and M. D. MacCárthaigh. Pp. 13–27. 1*s*. Vol. 50, Section A, No. 4: On the Connection of Dirac's Quantum-Electro-Dynamics and the Theory of Radiation Damping. By P. G. Gormley and W. Heitler. Pp. 29–49. 1*s*. Vol. 50, Section A, No. 5: The Equilibrium of Small Ions and Nuclei. By P. J. Nolan and R. I. Galt. Pp. 51–68. 1*s*. Vol. 50, Section B, Nos. 1, 2, 3: 1. The Electrical Production of Semen in the Guinea Pig (*Cavia cobaya*) and the Characters of the Ejaculate; 2. Note on the Sudanophile Fat in the Testis of the Dog; 3. Non-Septic Spermiophagia in the Male Guinea Pig (*Cavia cobaya*). By L. Collery. Pp. 38+5 plates. 3*s*. Vol. 50, Section B, No. 4: List of Irish Fresh-Water Mites (Hydracarina). By J. N. Halbert. Pp. 39–104+plates 6–14. 4*s*. 6*d*. (Dublin: Hodges, Figgis and Co., Ltd.: London: Williams and Norgate, Ltd.) [2610

To-morrow's Children. Issued by the Tory Reform Committee. Pp. 32. (London: Europa Publications, Ltd.) 1*s*. [3010

Post-War Development in Radio Engineering. Part 2: Education and Training. Pp. 12. (London: British Institution of Radio Engineers.) [3010

## Other Countries

Transactions of the San Diego Society of Natural History. Vol. 10, No. 8: The Widewinder, *Crotalus cerastes*, with Description of a New Subspecies. By Laurence M. Klauber. Pp. 91–126+plates 6–7. Vol. 10, No. 9: New Occurrences of Fossil Tapir in Southern California. By Chester Stock. Pp. 127–130. (San Diego, Calif.: San Diego Society of Natural History.) [1210

Publications of the South African Institute for Medical Research. No. 46: South African Food Tables; Chemical Composition and Vitamin Content of Common South African Foodstuffs. By Dr. F. W. Fox and Dr. L. Golberg. Pp. 123–162. (Johannesburg: South African Institute for Medical Research.) [1210

Commonwealth of Australia: Council for Scientific and Industrial Research. Bulletin No. 168: A Survey, Census and Statistical Study of the Horticultural Plantings on the Murrumbidgee Irrigation Areas, New South Wales. By A. Howard and G. A. McIntyre. Pp. 88+7 plates. Bulletin No. 170: Pea Mosaic on *Lupinus varius* L. and other Species in Western Australia. By D. O. Norris. Pp. 27+2 plates. Bulletin No. 175: The Recovery of Inter-Block Information in Quasi-Factorial Designs with Incomplete Data, 2, Lattice Squares. By E. A. Cornish. Pp. 19. Bulletin No. 176: The Analysis of Cubic Lattice Designs in Varietal Trials. By Dr. I. F. Phipps, A. T. Pugsley, S. R. Hockley and E. A. Cornish. Pp. 40. (Melbourne: Government Printer.) [1210

Gold Coast Colony: Department of Agriculture. Report on the Central Cocoa Research Station, Tafo, 1938–1942. Compiled and edited by M. Greenwood. Pp. ii+64. (Accra: Government Printing Department.) 4*s*. [1710

Western Australia. Report of the Geological Survey for the Year 1940. Pp. 20+3 plates. (Perth: Government Printer.) [1710

Western Australia: Geological Survey. Bulletin No. 100: Part 1, The Blue Asbestos bearing Banded Iron Formations of the Hamersley Ranges, Western Australia, by Keith R. Miles; Part 2, The Blue Asbestos Deposits of the Hamersley Range and their Economic Importance, by J. S. Foxall; with two Appendices, i. The Yampire Gorge Crocidolite Deposits (1937), by F. G. Forman; ii. Report on the Hamersley Range Blue Asbestos (1938), by J. S. Foxall. Pp. 62. (Perth: Government Printer.) [1710

Proceedings of the California Academy of Sciences, Fourth Series. Vol. 23, No. 37: Classification of the Ermines of Eastern Siberia. By E. Raymond Hall. Pp. 555–560. Vol. 23, No. 38: Notes on some Unfigured Type-Specimens of Chinese Mollusks from the North Pacific Expedition. By Teng-Chien Yen. Pp. 561–586+plates 50–51. Vol. 23, No. 39: *Rhinobrycon negrensis*, a New Genus and Species of Characid Fishes from the Rio Negro, Brazil. By George Sprague Myers. Pp. 587–590. (San Francisco: California Academy of Sciences.) [2310

Science in Childhood Education. By Prof. Gerald S. Craig. (Practical Suggestions for Teaching, No. 8.) Pp. viii+86. (New York: Teachers College of Columbia University.) [2310

Publications du Centre National de la Recherche scientifique. Monstruosités florales concernant particulièrement les nectaires chez une crucifère de la tribu des hesperideæ. Par Prof. Jean Motte. Pp. 10. Zoologie saharienne. Par Prof. L. G. Seurat. Pp. 58. (Alger: Centre National de la Recherche scientifique.) [2310

Annual Report of the Imperial Council of Agricultural Research for 1942–43. Pp. 36. (Delhi: Manager of Publications.) 2.6 rupees; 4*s*. [2710

Indian Association for the Cultivation of Science. Annual Report for the Year 1943. Pp. 2+32. (Calcutta: Indian Association for the Cultivation of Science.) [2710

Indian Central Cotton Committee: Technological Laboratory. Technological Bulletin, Series A, No. 60: Preliminary Observations on the Suitability of Cotton Cloth for covering Bales instead of Hessian. By C. Nanjundayya and Dr. Nazir Ahmad. Pp. ii+10. 12 annas. Technological Bulletin, Series B, No. 32: Variation in Copper Number, Cuprammonium Fluidity and Fibre Strength of Cotton stored under High Humidity. By C. Nanjundayya. Pp. ii+8. 8 annas. (Bombay: Indian Central Cotton Committee.) [2710

## Catalogue

A Catalogue of Books of English Literature and History (including Translations) printed during the Nineteenth and Twentieth Centuries. (No. 625.) Pp. 60. (London: Bernard Quaritch, Ltd.)