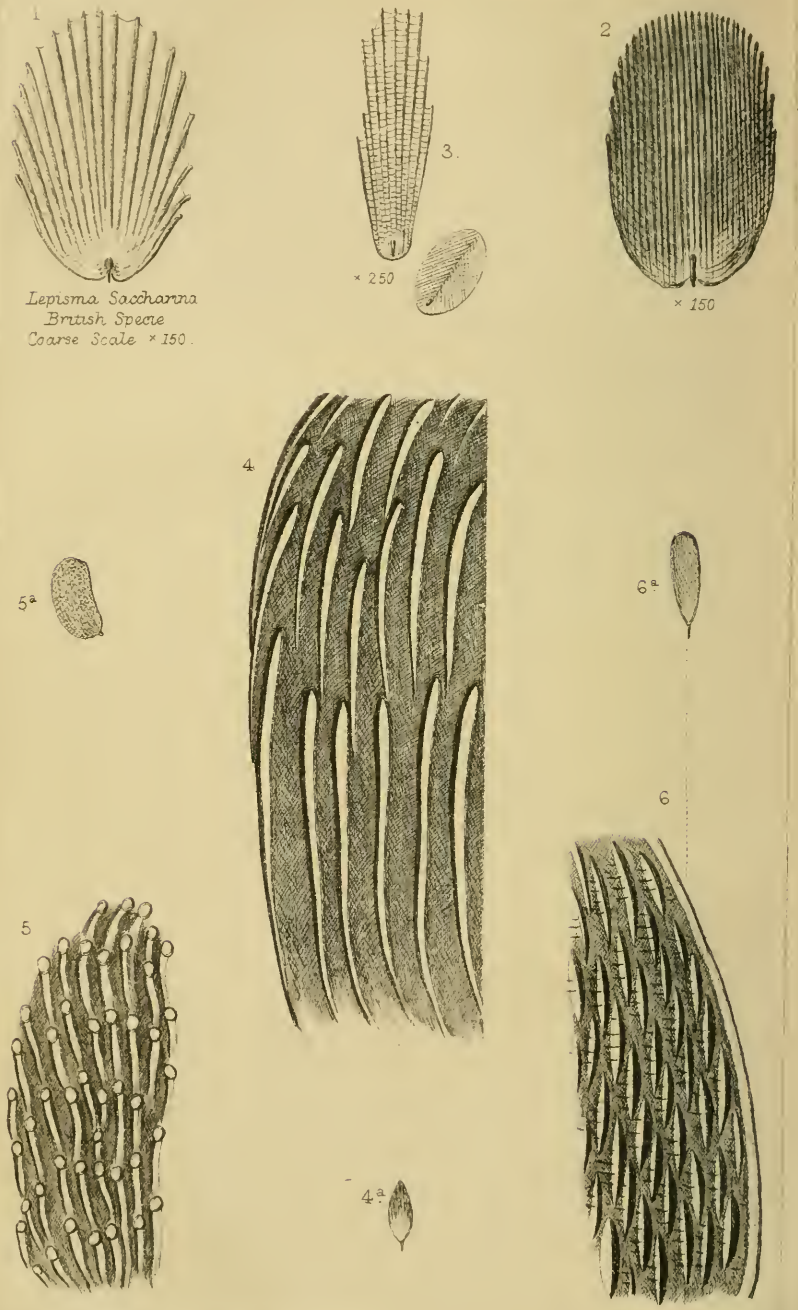

S. J. M'Intire del. Tuffen West sc. W. West imp.

Scales of certain Thysanura
(to illustrate Mr. M'Intire's paper.)

THE MONTHLY MICROSCOPICAL JOURNAL:

TRANSACTIONS

OF THE

ROYAL MICROSCOPICAL SOCIETY,

AND

RECORD OF HISTOLOGICAL RESEARCH

AT HOME AND ABROAD.

EDITED BY

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THE

MONTHLY MICROSCOPICAL JOURNAL.

JANUARY 1, 1870.

I.—*The Structure of the Scales of Certain Insects of the Order Thysanura.*

By S. J. McIntire, F.R.M.S.

(*Read before the* Royal Microscopical Society, *Nov.* 10, 1869.)

Plate XXXVII.

Some months ago I had the honour to submit a few observations to the Royal Microscopical Society respecting some insects belonging to the Thysanura, fam. *Poduridæ*—insects which deserve to be better known to microscopists than they hitherto have been, from the single interesting fact, one of many connected with them, that their scales are very beautiful microscopic obejcts. Since then certain views have been put forward relative to the structure of the scales of one of these creatures, *Lepidocyrtus Curvicollis*, which do not harmonize with my own, nor with those enunciated by the late Mr. Richard Beck, in whose published opinions I entirely concur. By the courtesy of Mr. Joseph Beck I was invited last April to inspect the drawings of Podura scales left by his brother, and on seeing them I was agreeably surprised to find that our observations, though quite independent of each other, were upon the same insects. In the drawings, which are exceedingly beautiful, the so-called "bead-like spherules," to quote from the recent papers on the subject, which are forming at the present time a bone of contention, are beautifully depicted, and the conclusion one must come to, therefore, is that they were well known to Mr. Beck. It is strange, then, that so accurate an observer as he is known to have been should not have made public the new views respecting the

EXPLANATION OF PLATE XXXVII.

Fig. 1.—Scale of	Lepisma Saccharina	×	about	150
„ 2. „	Lepisma from Bombay	×	„	150
„ 3. „	Petrobius Maritimus	×	„	250
„ 4. „	Greenhouse Degeeria	×	„	1500
„ 5. „	Templetonia Nitida	×	„	1500
„ 6. „	Degeeria Domestica	×	„	1500

markings, and corrected his former statements, in which he distinctly asserts his belief that the scale is a corrugated structure, if he believed them to have any real existence as spherules. But, on the contrary, the latest expression of opinion by that authority which I heard him give, was to the effect that no alteration had taken place in his views with regard to the *structure* of the scale of *Lepidocyrtus* (Podura scale).

In making some notes, as a necessary supplement to the short paper I have already communicated on the scale-bearing Poduræ, I may be permitted, perhaps, to state, with some diffidence, the objections which seem in my mind to militate against the new theories: I say theories because I have heard two urged. The most formidable objection to the " bead-like spherule " theory seems to me to be the fact, that all through the scales of insects, whether Lepidopterous or Coleopterous, so far as my knowledge extends, the markings are due to corrugations or wrinklings of one or both membranes of the scales. Now, if this plan of structure holds good so extensively in the *Lepidoptera*, *Coleoptera*, and *Diptera*, as I believe it does, I cannot help asking, " Why should not the same plan affect the *Thysanura?* " I think I shall presently be able to show, by comparisons, that it does, with certain modifications. The other theory is founded on the optical illusion of rows of beads which is often observable when two Lepidopterous scales of known striated structure lie across each other at any angle. A similar appearance and its cause is alluded to by Mr. Beck in his book on the Microscope, in treating of the scale of *Lepisma Saccharina*. It also is often seen, but I believe it is equally illusive, in solitary scales of certain foreign *Lepidoptera*, &c., where the strong longitudinal costæ are crossed at right angles by transverse corrugations. The theory which is advanced is to the effect, that the elongated "*beads*," or "note of exclamation" markings of the Podura scale, are due to striæ on opposite sides of the scale, crossing each other at an angle of about 17°. Against it I would only urge one objection, namely, that supposing this to be the true solution of the question, we ought to see the elongated beads forming patterns with regard to each other either of squares or rhombs; but they do not, as a glance at any of the scales the structure of which is disputed, will, I think, convince most observers. Therefore I am unable to accept this theory as containing the whole truth and its explanation.

Now what analogy is there between the scales of the *Thysanura*, especially *Podura* scales, and the scales of other insects?

If we compare the scales of *Lepisma Saccharina*, the British species, with the species of *Lepisma* lately alluded to in 'The Student' by Dr. Mann (as introduced from the East Indies into Natal, where its destructiveness is a great nuisance)—some specimens of which species I believe found their way from Bombay to the

London Docks in a case of furniture last year, and were kindly given me by R. T. Loy, Esq., [a very pretty insect of speckled appearance, black, brown, and white;] and another of silvery-white lustre from the West Coast of Africa, for which I am indebted to the same kind friend—a strong family likeness is perceptible, and the resemblance to the scales of the *Lepidoptera* is very striking.* (See Figs. 1 and 2.)

Passing on to the scale of *Petrobius Maritimus*, an insect common on the limestone rocks all round our coasts, remarkable for its activity, whether running or leaping, and known as the Bristle-tail, there is a variation to be noticed, in the fact that the corrugations in many of the scales radiate from a line up the centre, and these corrugations are crossed again by striæ at right angles to them. An apparently beaded structure is often seen, but I believe it is illusive, and the explanation of the whole of the appearances is clear to my mind as the result of corrugations (see Fig. 3). So much for the *Lepismidæ*.

Then, in the second division of the *Thysanura*, the *Poduridæ*, the first example I shall allude to is *Macrotoma*. As this scale is already sufficiently well depicted for the purpose in this Jonrnal, vol. i., page 208, Fig. 5 *b*, I need only call attention to it to show the striking similarity between it, the known scales of *Lepismidæ*, and Lepidopterous scales. There are strong ribs or costæ in a longitudinal direction crossed at right angles by minute wrinklings of the membrane, which under very high powers and certain illumination present the appearance (an illusive one, I believe) of rows of beads, as in the scale of *Petrobius* just alluded to. Some species of *Macrotomæ* show this feature better than others; *Macrotoma major* for instance.

In the scale of the greenhouse *Degeeria*† the corrugations are much coarser, fewer in number, slightly curved in direction, and interrupted in their course (more correctly speaking, perhaps, suppressed), so that they to a certain extent overlap each other. Of these short costæ the ends farthest from the tiny shaft of the scale are considerably the highest. In fact, I take these costæ to be the representatives of the "note of exclamation" markings in *Lepidocyrtus*. (See Fig. 4.)

In *Templetonia Nitida*‡ the structure is the same with these modifications;—the ridges are closer, and the suppressions or interruptions are more numerous. The sudden terminations of these little costæ moreover are perceptibly broader and higher in proportion to the length of the costæ than in the scale I have just

* These two scales are almost identical. Those from the speckled insect are a little more opaque than from the silvery-white one, but the shape of the scales and the other features are much the same.

† 'M. M. J.,' vol i., p. 203, Fig. 3 *b*. ‡ Ibid., Fig. 4 *b*.

spoken of. Hence, *if the tops of the corrugations only* are in focus, they appear as bright circular beads at pretty regular distances upon a number of indistinctly defined bright lines running down the scale longitudinally, but which sometimes anastomose with each other. A little deeper focussing dissolves this view, in which I think "the spherule theory" takes its origin, and converts the bright dots into "note of exclamation" markings nearly consecutive with each other. The scale then appears to be scored with ridges, like the exterior of one of the valves of a cockle-shell, but nevertheless it bears considerable likeness to the test scale—the scale of *Lepidocyrtus Curvicollis.* (See Fig. 5.)

In the scale of *Lepidocyrtus* I recognize the same plan of structure, and would account for the peculiarities of its appearance by the more frequent anastomosing of the corrugations and the greater minuteness of the costæ, which structure renders it more difficult to trace the course of the ribs. Microscopists generally also I think, fascinated by the beauty of the exclamation markings, have devoted all their efforts to the development of this appearance, and have neglected to a great extent to read the structure of this object as interpreted by transmitted light at a very oblique angle with the stage, and other modes of illumination at their command, because these modes alter the view to one much less captivating.

I will say no more respecting this scale, since I can add nothing to the accuracy or clearness of Mr. Beck's observations on the subject* beyond expressing my belief that the "*beads*" are only the most elevated points on the surface of the scale, which can be focussed alone, the slightest alteration of the focus dissolving them into the note of exclamation markings.

In the scale of the Speckled Podura, *Degeeria domestica* of Nicolet, a scale which I prize very highly for its beauty, I seem to find support in the opinion of the structure of the scale of *Lepidocyrtus* that I have formed. The insect is rare in England, but I have reason to think its scales are often sold on the Continent, where it is probably more abundant. The scale claims strong affinities with the other *Podura* scales that I have mentioned in the single characteristics it presents to the view; but in uniting these features in itself it is unique. For instance, it has minute cross-striæ like *Macrotoma*, the costæ are interrupted, and tend to overlap each other as in the Greenhouse *Degeeria*, while by direct transmitted light it exhibits the "note of exclamation" markings of *Templetonia* and *Lepidocyrtus* very beautifully; but in uniting all these features in itself it presents a perfectly distinctive character.†

* 'Quarterly Journal of Microscopical Science.'

† Occasionally, too, on certain scales the ridges anastomose very distinctly, and at these points certain illumination will give an appearance not very remote from the so-called spherules or beads of *Lepidocyrtus.*

According to the nature and direction of the illumination so the view of the markings is greatly changed, and it would be quite impossible except by the aid of photography satisfactorily to represent all the appearances it is possible to obtain.* I have chosen one view for representation (obtained by illuminating from below the stage at a wide angle), in which some idea of the real structure of the surface of the scale and the relation of the markings to each other, according to my opinion, is attempted to be shown. (See Fig. 6.)

To sum up, then. I do not believe that the *Podura* scale consists of globular beads placed at pretty regular intervals between two membranes. I believe it to be a case of "one apparent exception proving a rule," and that rule is, that the markings of the scales of insects, except where iridescence or the presence of pigment claims attention, are wholly due to corrugations of the membranes.

So far as I can judge, I believe both sides of a *Podura* scale are alike, and I have examined the scales uncovered as opaque objects with high powers. This proceeding is very difficult, and not wholly satisfactory, but I think I have seen enough to form an opinion upon it. I have never been able to separate a *Podura* scale into upper and lower laminæ; but there is every reason, I think, to believe that, as with the scales of other insects, there are two. For instance, in the scale of the Diamond Beetle (*Eupholus*), when detached and viewed by transmitted light, one lamina is seen to possess the iridescence and the other is transparent; and it has happened to me in endeavouring to obtain the scales from the wing of a species of Morpho in my possession, that single scales have been split, one lamina, the upper one, which readily comes away, being strongly corrugated and nearly translucent, and the other, which it was not so easy to detach from the wing, being intensely blue, and possessing extremely minute longitudinal striæ.

* This remark is equally true with regard to all the Podura scales, as Mr. Beck's figures of the scale of *Lepidocyrtus* testify.

II.—*Organisms in Mineral Infusions.*

By C. Staniland Wake, F.A.S.L.

(*Read before the* Royal Microscopical Society, *December* 8, 1869.)
(Communicated by Dr. Lawson.)

At the present time, when so much is being said and written about "spontaneous generation" and the conditions of life, there is no wonder that the mind sometimes, almost involuntarily, turns towards the "inorganic" world, and wonders whether the rocks whose origin is due to the activity through countless ages of microscopical organic creatures, may yet be made to restore some part of the vitality they have absorbed. The idea that this *might* be so led me to make the experiments the results of which I am about to detail.

My first experiments were with coal. The character of this mineral, and the varied and curious products which have been derived from it, make coal much more promising than any other of the organic minerals as a subject of investigation. There are, however, two conditions absolutely necessary (as will be well understood) to success. Life requires moisture for its development, and this moisture can be properly applied for the object had in view only when the coal or other mineral has been disintegrated, and its particles are made as fine as possible. When a piece of coal has thus been finely divided and its constituents placed in water, it will be found, when examined under the microscope, to contain (besides the larger pieces of black matter) irregularly-shaped black or brown particles, like portions of fronds, small pieces of crystalline substance—generally of a greyish hue, but often marked or mottled with brown—and numerous minute dark bodies, many of which are apparently of an oval form, the smaller ones having a rapid and regular vibratory motion. When an infusion of coal presenting these characters, made with distilled water, had been allowed to stand about a week, I examined some of the coal powder under the microscope, and found that a curious form of vegetation was beginning to be developed, sometimes from the larger black pieces of matter, but generally from the crystalline substance. This vegetation ultimately formed masses of irregularly-shaped stems, bearing one or more fronds, and its black colour and curious formation gave it a very strange appearance. This, however, is not the only form of vegetable growth to be met with in this infusion. Sometimes I have found fibres, apparently flattened and perfectly black, which occasionally attain great length. Other fibres resemble these, except in colour (which is of a greyish hue), and in their bearing at intervals, small black fronds. I have several forms of this grey fibre, in one of which the sides are indented at regular intervals, giving the appearance of its being composed of a series of cells, and in another instance two fibres seem to be plaited together. The latter is very beautiful, and more uncommon than the indented form. I before remarked that the vegetable growth generally springs from the crystalline substance. This is not surprising; for masses of this substance are often seen attached to the foliage of the vegetation, as though it were a result of fructification. In addition to this, there is a considerable quantity of gelatinous-looking substance, which appears to exude from the coal matter, or to be in some way connected with its growth, and which, although sometimes beautifully clear, often has a speckled appearance. The explanation of the speckled appearance I do not know, but occasionally a number of the small dark bodies above referred to are collected very near to the substance in question, as though they have some relation to it. Other phenomena connected with the coal infusions are the presence of small crystalloid bodies which float about freely in the water, and the projection of minute moving protuberances from various parts of the coal-substance and vegetation. As to the former, there is little to say beyond that they are not angular, and that one side which is less curved than the other is usually distinguished by a dark line at the margin. The protuberances, which sometimes take the form of "tubes," and at others of broad indented limbs, somewhat resembling what I have seen in other infusions to be mentioned, are of a dark colour. From their movements they appear to me to have relation to animal rather than to vegetable life, although they certainly are attached to the vegetation, often several tubes being together at the end of a frond. Occasionally a tube is much larger than usual, and then the movement is very perceptible, and on one occasion I observed distinctly the protrusion of a "tongue," which moved rapidly from side to side. These phenomena are not limited to any particular coal. I have experimented with *Cannock deep* (Staffordshire), *Swaithe* (Barnsley), Glyn Neath, Wigan, and Anthracite, all of which give analogous results, although, perhaps, the non-bituminous Cannock deep coal and that from Wigan show a more luxuriant vegetable growth.

It will be thought that whatever vitality the vegetation of the coal-beds may have retained, there can be no hope of producing life, vegetable or animal, from *chalk*. The chalk with which I have experimented was obtained from a well-boring in the Hertfordshire hills, and it consists of minute organisms of various forms, some round, others like straight or curved tubes, and many bodies resembling the ovate coccoliths so distinctive of the mud from the Atlantic depths. A number of minute moving bodies closely resemble, except in colour, those found in coal infusions. When this chalk, after it had been finely powdered and kept in water for some days, was examined under the microscope, tube-like protuberances were found to have been formed from the larger masses, and these had a movement like that of the tubes of the coal infusion. But this is not all. The particles generally presented the appearance of having a gelatinous coating, and in the course of several weeks they showed a tendency to become agglomerated, the mass having small bud-like projections at various points, the extremities of which are occasionally seen to move. These projections after a time become larger and irregular in form, and their movement is then much more perceptible. In fact, at the present moment the chalk of that infusion is, so far as I can judge, in a state of perfect vitality. It is evident from mere inspection with the unassisted eye that a change has taken place in the chalk, as what was at first a fine powder is now coarsely grained owing to the agglomeration of the particles and the elaboration, doubtless, of fresh cretaceous matter by its busy inhabitants. Independently, however, of this, there is other evidence of life. This evidence is furnished by the numerous small detached organisms which move freely through the fluid, and by the existence of very small white bodies, which can be seen rushing about over the microscopic field, especially after the slip has remained moist for twenty-four hours. A more curious proof, however, is found in the presence of what I can only suppose is a vegetable growth. This vegetation is in the form of long, flat, semi-translucent fibres, not unlike the grey fibres of the coal, but, judging from the shading, having sometimes a slight tendency to the spiral form. There does not appear to be any development of "foliage," but at various points there are chalky accretions, and occasionally the fibre is covered with these throughout its entire length.

If the recovery of organic life from chalk be strange, such a result in relation to *marble* must, considering the greater density of this mineral, be far stranger. When a small piece of this mineral is finely powdered, it appears to consist of crystals, with numerous minute particles in active movement. When, however, the marble has remained infused for some weeks, many of the crystals have the appearance of being covered with a gelatinous substance, from which various small "buds" have been produced. Some of these buds are longer than others, and move to and fro like the tubes in the coal infusion. Ultimately, however, there is so great a development of the coating substance as often to quite conceal the form of the crystal, accompanied by that of numerous small bodies of various sizes, some of which have much the appearance of the "buds" at first observed. These are evidently of the same character as similar bodies found in the chalk, and they sometimes form irregular moving projections such as those referred to as being produced in the chalk infusion. Other larger formations resemble the "finger" shaped organisms I shall have again to mention in connection with an infusion which has a close general agreement with that of marble. When a drop of the latter has been kept on a slip for twenty-four hours, a number of the small white bodies met with in the chalk infusion may be seen moving rapidly across the field. There are also great numbers of minute spherical bodies, such as are met with in the chalk infusion, although of a different colour, and they appear to have a short fibrous prolongation at one end. In the marble infusion I have, moreover, on several occasions found small jelly-like organisms, which progress by a sudden spring or with a spinning motion, and also minute forms like air-bubbles, which protrude from larger bodies, and slowly move from side to side. The development of fibrous growth in chalk prepares us to find this organic phase even in marble. In fact, I have met with it more plentifully in the latter than in the former, and generally, moreover, of a more truly vegetable appearance. While some of the vegetable growth consists, like that in chalk, of long flat greyish fibres, with small crystal accretions attached; at other times there is the same fibrous stem, but it has what seems to be a true foliage, much resembling that of the coal fibre, although of a grey colour and of a more crystalline appearance.

There is another mineral which, notwithstanding the apparent hopelessness of extracting any phase of vitality from it, I have experimented with, and with much the same curious results as those already detailed. I refer to the ordinary *emery* of commerce. This, when first placed in water and viewed under the microscope, does not differ much in general appearance from that which it presents after it has been "infused" for several weeks. When examined at this subsequent period the infusion will be found to contain numerous small bodies of various shapes, having a rapid vibratory motion. The greater part of the emery, however, somewhat resembles peculiar vegetation, of a dark colour by transmitted light, although by reflected light it is evidently red. Combined with this are numerous masses of a whitish, gelatinous-looking substance, almost exactly resembling that which is produced in connection with the vegetation of the coal infusion. The most curious phenomenon I have yet noticed is in connection with this emery crystalline substance. Projections from the black vegetable-looking matter often move to and fro; portions of it are sometimes protruded and drawn in again, much like what sometimes occurs in the marble infusion; and beautiful little "bubbles" occasionally show themselves. In the emery infusion alone, however, have I met with the protrusion of "fleshy" tongues. Indeed, on one occasion only have I seen it with certainty even in this, and then not until the drop of infusion I was examining had been on the slip for several hours. The forms of these protrusions were different. Of the two which I observed most attentively, one was white with black markings, and in shape broad at the base, but narrowing to a point; while the other was broad throughout, but much shorter than the first, the colour of the "tongue" being a beautiful pink. This preparation remained moist on the slip for several days, and on my then examining it I was surprised to find a great number of small dark bodies moving rapidly across the field, and the larger masses turning rapidly over and over in a most curious manner. These small dark organisms appear to be of the same character as the minute white organisms met with in the chalk and marble infusions, and they are of interest, as I have several times seen masses of the crystalline substance containing small dark moving bodies, such as those from which it appears to me that they are derived. Nor, strange as it may appear, is the emery infusion without fibrous growth. This is not plentiful, but on one occasion I found a long fibre, totally unlike anything I had met with before in any of the infusions. It was a slight gelatinous-looking fibre, of a light olive-green tint by transmitted light, with bluish black markings, occasionally tinged with pink, and the stem was "contracted" at regular intervals throughout its entire length. I have met with another specimen of this fibre, although this is not so perfect in form. Another vegetable growth from the emery is of a totally different character, it having semi-transparent stems showing a yellowish colour by transmitted light, and masses of emery being attached to it by way of foliage.

However improbable the above facts may appear, their truth can be supported, at all events, by others of an analogous character. There came into my hands recently a small quantity of sea-weed, with which was a lump of hard matter, somewhat of the appearance of very fine sand, the whole having, as I was informed, been picked up from the Gulf Stream by a passing vessel three or four years ago. On powdering some of this matter and treating it with distilled water I was not surprised to find vitality show itself. The crystals it contains appeared to be coated with the same gelatinous-looking substance, with its attendant granules, such as I have already mentioned in connection with the marble infusion. This substance is very abundant, and has a very "fleshy" appearance, and it is intimately associated with "finger"-like organisms, which are, however, sometimes aggregated into a considerable crytalline-looking mass. Altogether there is great resemblance between this infusion and that of marble. In the former, however, I have several times met with the *amœba* in a most active condition. This is a curious fact, but it was not so surprising to me as it might have been, as I had already met with the amœba under other circumstances equally strange.

There is certainly a difference between this last-named infusion and the others experimented with, seeing that the matter of which the one was made had not been detached from the living mass many years, whereas the other substances infused had existed as *rock* for countless ages. Another infusion of old mineral matter, which was obtained from a peculiar sandy deposit found in the cliffs near Bridlington Quay, furnished like results. This infusion presents much the same appearance as that of chalk, except in the absence of the ovate organisms so common in the latter. It contains, moreover, other forms of life of an interesting character, which want of space prevents me from particularly referring to. The submerged forest of Holderness has furnished me with another substance for infusion, and from this I have obtained an abundance of organic life of the most unequivocal character. Its most curious forms were small, almost transparent organisms (having a yellow nucleus), which move rapidly through the fluid, though small infusoria of several kinds were not wanting. My latest experiments have been with *mica;* but as these are not yet concluded, I will say merely that this infusion has produced great numbers of bacteria and other low animal forms, and that there is the formation of fine long fibres, sometimes in bundles, but often detached, and presenting real vegetable growth.

Before closing this paper I would mention several curious facts in connection with the above infusions which I cannot satisfactorily explain. The most curious is the occurrence of *amœbal* life. This I have met with in three infusions; one of them being of marble, another of emery, and the third of coal. The most numerous examples of amœba were met with in the marble infusion, which produced the *Amœba princeps*, another kind which, somewhat slug-like in form and without visible protrusions, may have been only another phase of the princeps and the *Amœba radiosa.* Of this last species I only met with one example, but the others were very numerous. The *emery* provided two splendid specimens of *Amœba radiosa;* while in a coal infusion I have found several specimens of two other species. Of these, one, which contained a large number of crystalloid bodies, is probably a species noticed by Mr. Carter, although I cannot otherwise identify it. These crystalloids appear to me to resemble the curious bodies of a similar character already mentioned as existing in the coal infusion. The other amœba from this infusion was much larger, and somewhat resembles illustrations of *Amœba guttula.* The almost transparent *ectosarc* of this amœba, which it protruded as a broad lip, was very apparent as it moved from place to place along the vegetation stems to which it evidently adhered. On one occasion when the lip was curved, I caught sight for an instant of what appeared to be very small cilia in a state of intense vibration. I have not mentioned the presence of these amœbæ earlier in the paper, notwithstanding their undoubted existence in the chalky sand from the Gulf Stream, because the infusions in which they occurred (except that of coal, which was in a covered wine-glass) were kept in *corked* bottles. All the other infusions were in stoppered bottles; and in these I have found neither the amœba nor any of the other organic forms, which for this reason I have made no mention of, produced by the other infusions. In fact, all the corked infusions seemed to have abundance of infusorial life, although the corks had not been before used, and were therefore free from moisture until they came into contact with the water of the infusions themselves. How the *amœbæ* got into the coal infusion I do not know; but I do not believe they were deposited there by the air or the water. I much rather think that they have had their origin from the gelatinous-looking substance which is so abundant in the coal infusions, and which often has much the appearance of the amœba itself. Moreover, the crystalloids contained in one of these creatures seemed to be not merely foreign bodies. They had the appearance of being in some manner connected with the organism itself; and I would suggest that the independent presence of the crystalloids in the infusion is due to the breaking up of amœbal organisms. I have been more puzzled by meeting with *Rotifer vulgaris* in one of the coal infusions, than by anything else: not so much perhaps by its presence, it having occurred only once, as by its curious appearance when my attention was first drawn to it. It looked exactly like a large piece of crystalline substance, of a regular oval form, but curiously marked. I thought I had found an amœba in an encysted state, but about a minute afterwards, on again looking at it, I was astonished to find a rotifer in full activity.

I shall not attempt here to draw any general conclusions from the phenomena above detailed. I find confirmation of some of my experiments in the fact, recorded in the 'Journal of the Chemical Society,' of the discovery by Mr. Roberts of a microscopic fungus in colloid silica obtained by dialysis. I have met with a still stronger confirmation, however, in the "chalk-mud" obtained from the Atlantic deep-sea dredgings, some of which, through the courtesy of Dr. Carpenter, I have been able to examine. In this I at once recognized forms analogous to the ovate bodies of the chalk infusion, and also the minute detached particles (evidently independent organisms) which answer to the granules of Bathybius, and which are present also in the marble infusions. The "fleshy" substance of several of my infusions appears to answer to the protoplasm of Bathybius. In the "chalk-mud" there is, moreover, an approach to the development of "vegetable" stems, which is still further confirmatory, although this may, perhaps, show that the fibrous growth I have met with in the chalk and marble infusions has a connection with animal rather than with vegetable life.

III.—*The Markings on the Podura Scale, being a Postscript to a Paper on High Power Definition.* By G. Royston Pigott, M.D.

Mr. Reade having kindly furnished me with some slides* of Podura Scales, *viz.* Mr. M'Intyre's specimens of "Inner Surface of *Degeria Domestica* and *Macrotoma Major*," I find that the upper beading is so coarse that it may be plainly made out with a good half-inch objective, a C eye-piece and 16 inches of tube. At Mr. Reade's request I exhibited the beading to him very rapidly (very little adjustment being required) with the half-inch.

They may be seen also on a dark field, by employing oblique light from the ordinary concave mirror, at a greater obliquity than the semi-aperture of the half-inch objective. I now see them. The axis of the scale is inclined at about 30 degrees to the direction of the light. By this light they appear yellowish green. I see no under-beads.

Fitting the hydro-objective to the one-eighth Powell and Lealand, I shall expect a gorgeous field.

A lady, who is now viewing the scale, says "the beads look just like rows of peas in the pod." But the water is now insinuating itself, and bright spots four times the size of the beads arise like blebs of a light green colour. One *rouleau* vanished instantly.

The "green peas" are mingled in alternate rows with the upper deep orange-red beads: and each set can be seen with black crescentic shadows. The water advances and gradually obliterates the vivid and lovely prismatic colourings.

But to me, more striking than all those appearances are our old friends the black markings of the Podura reappearing alongside of our newer acquaintances, the upper and lower beads. At the same time the lattice-work of rows of beads is extremely beautiful.

I now examine the other Podura slide from insects bred by Mr. M'Intyre. Same arrangement without condenser.

The Macrotoma Major.—The beads now appear in parallel rows; orange-red above, and between them and below them appear rows of intensely blue beads. They all gradually diminish as they go towards the quill end of the scale, appearing beautifully less.

They are very easily seen in any position of the scale with ordinary oblique mirror illumination.

These scales come most opportunely, for they render that easy which is exceedingly difficult in the regular test scale of my plate.

* It is very noteworthy that both the upper and under sides of these scales appear identical in their physical phenomena—structure and colour. Mr. McIntyre informs me the insect is here pressed *upon the slide*, instead of upon the cover, to show the under surface upwards.

I had the satisfaction of exhibiting several times to Mr. Reade, the upper and lower beads of the test-scales he brought with him, and we were both greatly pleased with the beautiful, I might say exquisite, colouring of the rows of beads or rouleaus, according as they were in the upper or lower plane. Not less remarkable were the prominent and *enlarged* appearance of every fourth or fifth bead of a vivid azure blue: a phenomenon capable, no doubt, of good physical demonstration.

The *azure blue scales* described in the paper are similar in structure to the *Macrotoma Major*; but very finely marked, more delicate and transparent.

Altogether this new test promises a new field of research.

IV.—*Cultivation, &c., of Microscopic Fungi.*

By R. L. Maddox, M.D.

Plate XXXVIII.

The cultivation of Microscopic Fungi offering such a wide and tempting field for research, and the few experiments conducted in reference to "Mucor Mucedo," as stated in a previous article, p. 140, vol. ii. of this Journal, being incomplete, others were set forward without delay; but unfortunately, from unavoidable absence from home shortly after, they must for the present be entirely passed

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EXPLANATION OF PLATE.

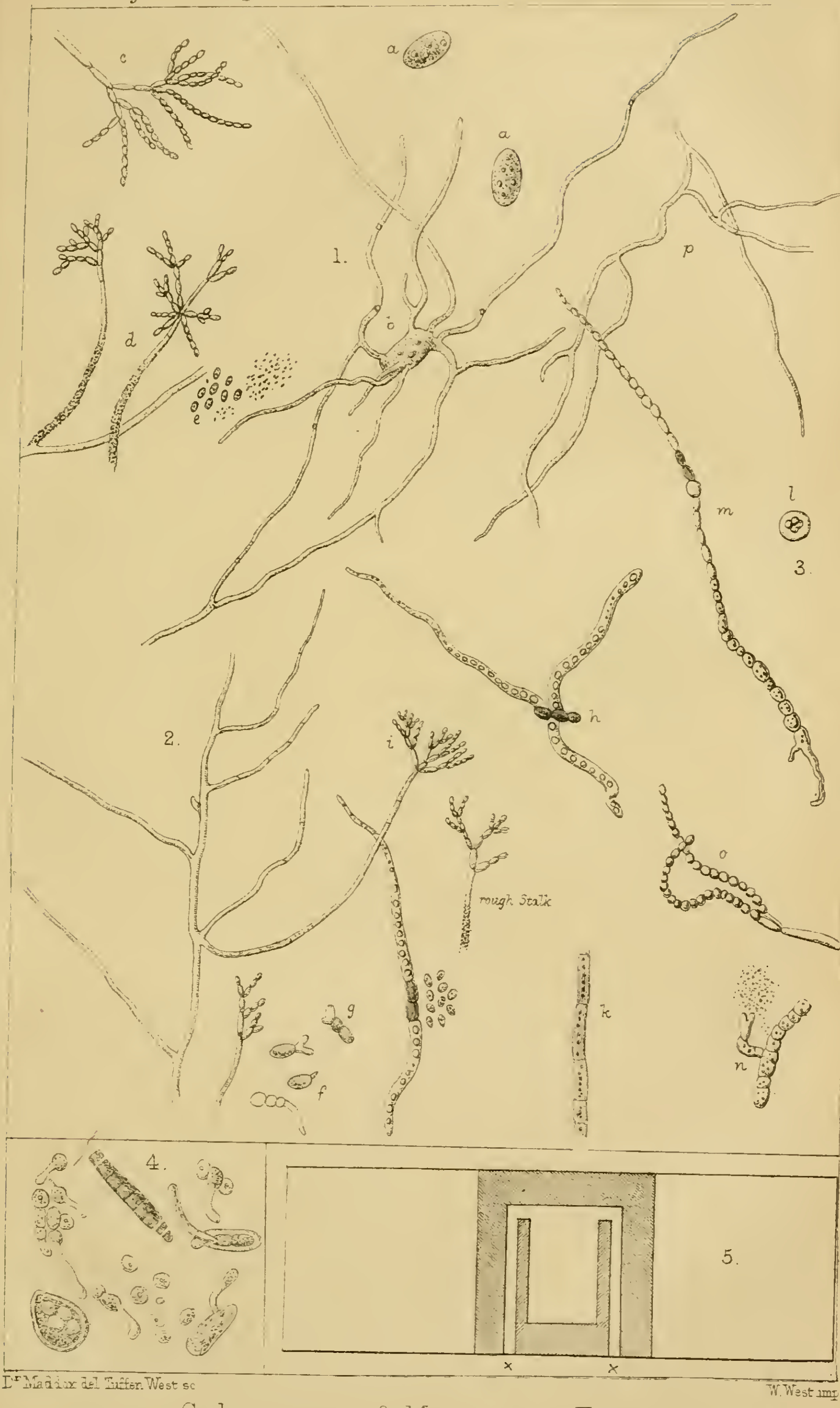
Fig. 1.—*a. a.* Spores or conidia of *Oidium Tuckerii.*
b. The same, germinating.
c. Pedicels with fruit.
d. Older stalks, rough on the outside.
e. Small nucleated spores and bacteria.

,, 2—*f.* Spores or conidia from brand on orange leaf.
g, *h.* The same, germinating.
i. Stalk with spores—one—rough on the outside.
j. Small spores nucleated.
k. Part of an old mycelial thread, with minute bodies enclosed between the septa.

,, 3.—*l.* Spore or conidia from brand on leaf of a climbing plant.
m. The same germinating and producing irregular cells.
n. Terminal cell supposed to have discharged the minute bodies.
o. Moniliform rows of *Penicillium glaucum.*
p. Mycelium from the brand on the leaf.

,, 4.—Figures of the bodies now found (Dec. 13) in *the two large drops* of juice alluded to in pp. 144, 145, vol. ii., of this Journal, representing the true spores, the small schizonematous bodies and minute granules or molecules, and which show them to appear at least as fungoidal elements.

,, 5. Cultivating slide.



Dr Maddox del. Tuffen West sc. W. West imp.

Cultivation of Microscopic Fungi.

over, being too imperfect for publication, and others only slightly sketched.

As the subject is likely to occupy considerable attention at home and abroad, and different observers employ different plans, I venture to shortly notice the method adopted by myself, which proved useful and inexpensive, and allude more particularly to that employed by Drs. Billings and Curtis, as stated in their portion of the late "Report on the Cattle Plague in America."

The great difficulty, if not almost absolute impossibility, of conducting any series of experiments, which, however free to legitimate deduction, shall not be open to useless controversy, determined me to use only such means as might be called simply precautionary, of easy arrangement and manipulation, one object being to determine some useful form of cultivating-slide with the ordinary 3-inch microscopic object-slide. Several plans were tried, but the one now described selected. It was made as follows, to be used with thin $\frac{6}{8}$ths of an inch square covering-glass, such as is usually employed for a $\frac{1}{12}$th-objective.

A piece of tin-foil, of the stoutness of ordinary note-paper, was cut into squares of one inch diameter, a portion was then removed from a square by cutting it from one side almost to the opposite, then at right angles and again at right angles, thus leaving a strip of the shape of the letter ⊔ with a flat base, and limbs of equal length and width; from the piece removed a narrow slip was cut from three sides, and then a portion removed from it, as in the first piece, thus forming a smaller letter ⊔; the largest was cemented to the surface of a well-cleaned slide with easily-melting marine glue, or Bell's cement thickened with gum-shellac; the smaller one was then similarly fixed within the larger one, the limbs being turned to opposite sides of the slide, as seen in the figure, thus affording a central space for the material under examination and a narrow channel each side for the admission of air.

The fungi or spores selected were placed on the cover, under the dissecting or erecting microscope, with a *droplet* of the medium to be employed or cultivating solution. This was examined under the microscope with a power of 150 or 200 diameters, and if satisfactory, placed at once over the central space of the slide (which, after cleaning with liquor potassæ water and alcohol, if cemented with marine glue, or diluted alcohol if with Bell's cement, was kept turned upside down, one edge resting on a piece of glass until wanted), and the edges of the thin cover resting on the slip of tin-foil, were then closed up with wax softened by oil or with Bell's thin cement, except at the spots corresponding to the two narrow passages marked * * in the figure. If thought necessary, a duplicate slide was similarly prepared, one being left in diffused light, the other in darkness in the moist chamber.

The medium should *not touch* the inner edges of the tin-foil at any part.

To procure a satisfactory moist chamber occupying but little space, the slides were set in small porous battery cells, previously thoroughly cleansed and moistened with freshly-boiled water, and set in a basin of the same to the depth of half an inch, the basin, with levelled edges, being covered by a plate of clean glass. Those slides intended for diffused light were placed in cleaned damp white porous cells set in water as the others, and covered with glass, the face or cover side of the slide leaning towards the inner surface of the battery-cell; a small cell would thus hold four slides occupying little space. The external temperature, if not sufficiently high, must be raised artificially by a water-bath, or the basin set in a warm place.

The slides when removed are bedewed with moisture; but if rested on end, in a clean tumbler (warm if necessary), and covered with a bell-glass, this soon disappears, and permits examination with any power up to a $\frac{1}{12}$th.

Although the slide and cover were generally fogged with moisture, I sometimes found the droplet had considerably diminished, and the slide presented surfaces barely moist, especially if cover and slide had not been most carefully cleaned. To meet this difficulty, which was somewhat serious, especially if the slide had to be watched many days, it occurred to me that if an artificial cultivating fluid was made, which would be hygrometric, besides containing the elements of nourishment considered useful for the colour and growth of the fungi, much of this difficulty might be overcome; hence, after several trials, the following was selected and successfully used:—

Dextrine, 2 grains; phosphate soda and ammonia, 2 grains; saturated solution of acetate potash, 12 drops; grape sugar, 16 grains; freshly-distilled water, 1 ounce; boiled in a clean glass vessel (thin beaker or large test-tube) for 15 minutes, covered whilst boiling and cooling; when settled poured into perfectly clean two-drachm stoppered bottles, and set aside for use. Sometimes with the cultivating fluid other media were added on the slide.

To preserve some of the perfect forms of fungi found on plants, or produced by cultivation, &c., a saturated solution of acetate of potash was employed with success. There is, however, a little difficulty often from the repellent nature of the heads when beset with spores, and retaining air in their interstices, in using this medium for mounting; but flooding the specimen momentarily with alcohol diluted to the point when it readily touches or wets all the surfaces, and draining it from the slide before applying the mounting solution, readily overcomes this little trouble, and with scarcely any appreciable change in the appearance of the spores or mycelium; at least such is my experience. I prefer it to glycerine or any other solution used. The edges of the cover, if wetted by the acetate solution, attract moisture readily; so it is best, if the specimen be worth closing up, to dry the edges by a sable pencil and twist of tissue-paper before applying Bell's cement, at first thin, then thickened, as aforementioned.

On the 1st September, a few of the spores (conidia or sporanges) were removed from the surface of a grape, covered with *Oidium Tuckerii*, and sown as described in the cultivating solution, placed in the porous cell in the moist chamber, and left in diffused light. On the 4th there was an abundant mycelium from several of the spores or conidia (Fig. 1 *b*), afterwards becoming of a light-brown colour, divided by septa, enclosing generally two oil globules or minute spores. Later, on the 15th, from the mycelium several stalks had sprouted, and fruited into the air-space beyond the edge of the liquid; the fruit resembling Penicillium, but the spores in rows on the pedicels were slightly oval. Some of the older stalks had a character which I had not noticed before, and which I have endeavoured to show in Fig. 1 *d*. They appeared rough outside, or covered with most minute bodies. I am of opinion that this was not an accidental character, but from absence was unable to trace this point further, or whether such stalks might not break up into other bodies.

Lying about amongst the threads were numerous minute bodies (?)bacteria, also small oval bodies with a central spot or nucleus, mostly collected into groups (Fig. 1 *e*). It is possible these may have been drawn in from some slight shrinking of the fluid, and have originated, as supposed, from the heads that fruited in the air-space; but whence they were derived I am uncertain.

On August 30th, a small speck from a brand on an orange-leaf (from the same greenhouse), which for trial had been set in fresh gooseberry juice, was removed, as it had not altered, and set in the cultivating solution, &c., in the light. The spores or conidia commenced sprouting very shortly after, and soon became filled with oil globules or spores, as in Fig. 2 *g*, *h*. On the 5th many of the mycelium threads had formed heads outside the fluid, the spores being very slightly oval (Fig. 2 *i*).

In the fluid lying by the side of some of the original conidia or spores which had sprouted were minute oval bodies with a central nucleus in each (Fig. 2 *j*). On the 15th the stems of the older fruited threads appeared roughened on the exterior, with minute bodies, as in the former case. The young threads were growing beautifully, and filled with closely-packed oil globules or spores, no septa being distinguishable, while in the older mycelial threads, which were of a brownish colour, septa existed; each division inclosing about six small bodies (Fig. 2 *k*).

Another slide was set from a black brand (found on a leaf of a climbing plant, * * *, in the same greenhouse) with the cultivating solution on the 1st September; on the 5th some of the conidia or sporanges showed in their interior four distinct spores (Fig. 3 *l*); some of the loose spores gradually sprouted, forming threads consisting of irregularly-shaped cells, many of them containing from one to four, either oil globules or spores (Fig. 3 *m*); these, like the former, were not tested with ether, &c., as it was desired to preserve the specimen intact. On the 15th the threads were full of these, and along their edges thousands of bacteria-like bodies were present. I am doubtful if these were not ejected from the sporiferous (?) ends of some of the offshoots, as in Fig. 3 *n*. Though I had not witnessed their ejection, their position and the appearance of the terminal cells in some parts led to this supposition. The heads with spores in the air-space resembled *Penicillium glaucum* with its moniliform chain of round spores, and were larger than in the other specimens (Fig. 3 *o*). The mycelium from the same brand is seen in Fig. 3 *p*. At this interesting point of inquiry they were obliged to be neglected, and are only alluded to here in this imperfect sketch, rather to show the utility of the cultivating slide and solution than otherwise; for in the two last experiments it would be difficult to prove more than that the fruit sprang from some particular spore of those found in the brand, which possibly might be of a mixed character.

In the very valuable and suggestive report of experiments by Drs. Billings and Curtis, of the U.S. army, appended to the comprehensive and extended researches furnished by Prof. John Gamgee, M.D., on the cattle plague in the United States, under the various titles of "lung disease, or pleuro-pneumonia," "the ill effects of smutty corn on cattle," and "the Texan, periodic or splenic fever," undertaken by the authority of the commissioners of agriculture, we find the microscopic examination and the cultivating experiments handled in a very careful, instructive, and trustworthy manner. The omission of any experiments carried out in *darkness* in reference to the cultivation of fungi from the healthy or pathological tissues or fluids, more especially those relating to the most serious and difficult question of the cause of Texan or splenic fever, which destroys life so largely, is to be regretted, as it leaves this point open for future investigation.

Experiments performed outside the body, if darkness be omitted as one of the conditions, however carefully temperature and moisture may have been regarded, may not sufficiently closely imitate the natural relations, and determine a difference as regards the results obtained. This is not to say that such differences do exist, nor is it to be expected that all the circumstances can be rendered similar, hence there may remain always some degree of questioning, but this condition adopted would tend to narrow the circle. My object is not to enter into a review of this most interesting and valuable

Report,* but for the benefit of those who may be engaged in or undertake such examinations, it may be useful to give a brief statement of some of the methods employed, and the results arrived at by those excellent observers.

The questions they have endeavoured to answer are:—

1st. "Are any forms of cryptogamic growth present during life in the blood or secretions of diseased animals?"

2nd. "If so, of what character are they, and what is their probable source?"

All relation between the cryptogram and the disease, as cause or effect, being neglected.

The supposition by some, which they give succinctly, is that "disease is produced by the presence in the economy of minute particles of protoplasm (micrococcus of Hallier), resulting from development and breaking-up of the spores or mycelium of a fungus; from which granules, they assert, can be developed perfect forms of fungi, of recognizable genera and species, by proper 'cultivation' outside of the body of the animal fluids containing them." In the fresh venous blood from a pleuro-pneumonic cow under 1200′ diameters, they found no unusual appearances to healthy blood as regards corpuscles, spores, or mycelium, but, "single or in masses," minute granules or molecules were seen in the field as "glistening points," if not at first, at least after exposure to the "air for a few hours." These particles have been claimed as the course of disease, pronounced to be vegetable in character, and "as being developed from, and capable of reproducing certain common fungi popularly known as rusts, smuts, or molds."

The fluids were obtained in a state of purity, by using short glass tubes about $\frac{3}{16}$ths of an inch in diameter, made by sealing one end at the flame of a Bunsen burner, holding the tube in it nearly upright with pincers till it is red hot, rapidly drawing the tube out to a narrow neck and closing it in the flame; the hermetically closed tube with a partial vacuum is called a "vacuum tube." The insertion of the point into a vein, compressed above and below, when broken off allows the blood to enter, and the tube on withdrawal is immediately sealed by the flame of a spirit lamp. The fluid can now be kept for experiment without the entrance of foreign spores; but to place any portions of this in conditions necessary for cultivating without risk from their entry, offers a difficulty, upon which those observers reasoned as follows, and which so entirely corresponds with my own views as expressed in another paper, that I venture to quote their words.

"By no amount of precaution or complexity of apparatus is it possible to secure such absolute isolation of a fragment of tissue or

* Reports of the diseases of cattle in the United States, made to the Commissioners of Agriculture, Washington, Government Printing Office, 1869.

c 2

a quantity of blood from possible contact with foreign spores, that the results obtained from its cultivation can be considered as positively conclusive. By no means known to us can a piece of lung be transferred from the body of an animal to the interior of a glass flask, without contact with the atmosphere and with instruments, nor even with the more manageable blood can we be absolutely certain when we see its surface covered with mold, that the possibly single spore from which that forest sprang must infallibly have been in the vein of the animal whence the blood was drawn. It was felt, therefore, that to adopt at the outset extraordinary precautions against the introduction of foreign spores, would be more apt to lead to error than even taking none at all. The method of comparison was therefore resorted to." Thus healthy and diseased tissues and fluids were similarly treated, using ordinary precautions.

The "isolation" apparatus they adopted is a thin, flat-bottomed flask, with a cork dipped in paraffin at the neck, pierced for a tube bent at right angles, closed at the outer end with a plug of fine cotton wool.

The culture apparatus used was a large flat glass cell, containing a porcelain stand, rather higher, which supports a glass shelf for holding the slides and watch-glasses for daily examination, this covered by a glass bell jar closed at the neck by a cork dipped in paraffin, through which is passed a right angle bent tube, the outer end plugged with cotton, and the interspace between the outer cell and glass jar filled with a strong solution of permanganate of potash. These somewhat, as stated, resembling Hallier's, but no means were added for drawing fresh air into the vessel.

The growing slide recommended is the ordinary 3×1 inch slide, having "a piece of thin, fine, white blotting-paper of the same size, with an opening in the centre three-fourths of an inch in diameter, or a little less than that of the thin glass cover used. The edges of the paper may be cemented to the glass with a little Canada balsam, although this is not necessary. To use it, put it in strong alcohol for ten minutes, then in distilled water for the same length of time; free the central opening from water; place in it a drop of the fluid to be cultivated, and cover it with a thin glass cover." It is to be kept flat and set in a culture apparatus: when "water alone is used as the isolating fluid," a piece of sewing-thread rests on one end of the slide, the other end dipping into the water. If not to be set in a moist chamber, the paper is covered with a corresponding "piece of thin sheet rubber or oiled silk," with a similar central aperture. If the fruit is to be developed, "a groove should be cut in the paper to the edge of the slide" to admit air. A very ingenious form of development apparatus used was a glass beaker containing a little water, closed at the top by a thin sheet of rubber having suspended from its centre, by a thread, "a strip of thin blotting-paper which had been previously soaked in alcohol and distilled water, and on which the material to be cultivated had been placed." Perhaps a similar employment of a few long fibres of asbestos might be useful, as they could be heated red hot so as to destroy any germs, and if the object to be cultivated was placed half-an-inch from the end, this might be allowed to dip into a small cell having the necessary cultivating solution, and the cell itself surrounded by water for a moist chamber.

The substrata employed for the nourishment of any fungi present, were of various kinds, natural liquids, animal and vegetable, also solutions of sugar, cane, and grape, and solutions of tartrate of ammonia, ashes of yeast and water, &c., &c., some boiled, and if filtered, reboiled.

The experiments are numerous and most interesting, and the conclusion derived from them is "that, in the contagious pleuro-pneumonia of cattle, there is no peculiar fungus-germ present in the blood or secretions, and that the theory of its cryptogamic origin is untenable."

With the blood from the splenic disease, "which was placed in various substrata, and compared with healthy blood, the results were in all cases the same, *i. e.* production of penicillium, coremium, and mucor."

They found in the blood, bile, and urine of animals slaughtered in Texas, "apparently healthy while alive, yet after death" presenting characters of splenic fever, "minute bodies corresponding to the micrococcus of Hallier, which exhibit the same behaviour with reagents as the spores of fungi."

These micrococci are undistinguishable from "similar bodies" found in "any blood in an incipient stage of putrefaction." More, over, cultivation, in various ways, of the blood containing them-failed to invest them with a special and important character. The growths were "composed of the commonest mold, and instead of being unique as to species or even genus, comprised various forms and sizes of cryptococcus, torula, penicillium, coremium, mucor, and the so-called schyzosporangia of Hallier" "either simultaneously or successively developed." Healthy blood they found to yield the same results, but more slowly.

Ustilago, coniothecium, or tilletia, were not obtained, and as said, "probably due to the circumstance that *no specimens of these fungi were ever brought into the room where our experiments were conducted*" (the italics are ours). These cautious observers thus deduced the hypothesis from their experiments, the cultivation yielding only the commonest molds, "that the disease rather destroys the vitality of the blood to such a degree as to render it capable of supporting and nourishing a low form of these ubiquitous fungi, which perish when introduced into a healthy subject," and suppose these granules, if fungous in their nature, should be considered rather "as an effect of the malady, whether constant and inherent, or altogether fortuitous," "than imagine a deadly disease occurring only under certain rigidly prescribed conditions, as caused by the presence, in the economy of the germs, of fungi notoriously harmless and of universal occurrence." They admit the possibility of these fungi in the fluids of the diseased animals becoming the "carriers of contagium."

The Rev. M. J. Berkeley, to whom we are so largely indebted for our knowledge of microscopic and other fungi, in his paper, page 14, vol. ii., of this Journal, thus expresses himself in reference to these small bodies: "But, whatever may be the origin of these minute bodies in question, whether from pre-existent spores or the fortuitous concourse of chemical and other energetic forces, it is a matter of immense importance to ascertain whether they have any real connection with disease, and it is at once obvious that the question as to their origin becomes eminently essential." Everything, therefore, which may help forward the difficulty, though it may not overcome it, has its appreciable value.

It is, perhaps, at this point of interest to notice the curious results marked by Professor Gamgee of cattle driven over the trail of Texan cattle, which themselves may have shown no signs of the disease while alive, conferring the disease upon the new comers in a most fatal manner, yet the survivors of those "animals contaminated by feeding on Texan trails have not in a single instance propagated the disease to other animals," &c., nor do the originally infected cattle occasion the disease by actual contact. Professor Gamgee remarks, it is "not the breath, nor the saliva, nor the cutaneous emanations which are charged with the poisonous principle, but the fœces and the urine." The conditions, he states, are modified by weather, season of year, and time. This alone, considering the sad waste of life and actual loss of property to those engaged in the produce of stock, or as "packers" for a vast consumption in their own country or in others, where preserved meat may, under emergency or price, influence the markets, is a field of research that cannot be too widely investigated. From the observations of others, speaking of the ill effects of diseased corn in cattle fed with it, he remarks that pigs "acquire a taste for it, and after eating it a few days their bristles drop out, there is an awkwardness in the movements of the hind legs, and atrophy affects them. Eating the pigs produces no ill effects on man." "Hens lay eggs without shells;" monkeys and parrots fall down, "unable to rise again." "The indigenous dogs and deer that enter the corn-fields at night suffer in the same way;" yet, in an experiment, two cows were fed with food, somewhat dry in one case and wetted in the other, and mixed with smut fungi; the only effect observed was, "the cow fed on the dry food lost flesh," on the "wetted food gained in condition." They consumed forty pounds of smut in three weeks, the appetite being voracious. Thus we find how much we have to learn amongst the diseases of cattle, and how such important investigations amongst inferior beings may tend to unshroud the contagious, endemic, and epidemic maladies that encircle ourselves. We have paid too little attention to the excreta in large and small communities, and here we see opened before us, by vast and devastating results, an inquiry of how far the statement that the Texan or splenic fever, "an enzootic disorder, probably due to the food on which Southern cattle subsist, whereby the systems of these animals become charged with deleterious principles, that are afterwards propagated and dispersed by the excreta of apparently healthy, as well as obviously sick, stock," may prove correct; and whether, under a constant inquiry relative to zymotic diseases generally, the importance of experimental development of fungi might not be more seriously urged in this and other countries.

Dr. Gamgee says that the spring grasses, after the frosts of winter have killed the old ones, are healthy, and continue so unless Texan or Florida cattle are again driven over them. Mr. H. W. Ravenel, the accomplished botanist of South Carolina, who accompanied Dr. Gamgee, found no parasitic fungi on the young grasses or hay at the time of their visit, that could in any way account for the disease, nor did he find the coniothecium Stilesianum which Hallier suggested should be "looked for in the food of the wild bullocks."

Besides the foregoing brief notice of the methods employed by Drs. Billings and Curtis, it is necessary to allude shortly to another which may yet have very important bearings in the solution of some points difficult to study; they carried out a series of experiments in reference to the passage of "bacteria, vibrios, and molecules, either single or in chains (*Monas, Microzymas, Micrococcus, Leptothrix, Zooglea, and Schizomycetes of various authors*)," through thoroughly moistened filtering paper, while, as originally shown by Mitzscherlich, "yeast cells will not pass," and that none of the aforementioned bodies pass through vegetable parchment, though this is open to the passage of fluids; the apparatus used being simply a test-tube open at both ends, one end is now closed by doubled strong filtering paper, tied by waxed thread, which end is rested on a glass rod inside a four or six ounce glass beaker, rimmed, and after certain precautions the fluids for operation were placed, the one in the beaker, the other, the putrefying or fermenting fluid, in the tube, and the beaker finally closed by lightly stretching and fastening sheet rubber over the top: the solutions and slides, prepared with the same fluids, were very numerously varied; putrefactive fluids determining the formation of yeast-cells in the external fluids which previously contained none; in other cases yeast-cells being found in the tube and molecules or micrococcus in the beaker. From these many and varied experiments, they consider it probable "that some of the bacteria and micrococcus germs are really fungoid in character, and capable of being developed into higher forms."

Although they found no fungus germs in the blood of many healthy and diseased animals, in others, germs existed in the blood during life, as they developed in the blood in the "vacuum tubes" filled from them; but they question whether those germs would be developed without some "dead organic matter as a pabulum." The common mildews are stated to stand, in point of frequence, thus: penicillium, then mucor, next aspergillus, these varying as to growth, colour, size, &c., in many ways.

The conditions under which bacteria and the minute germs of fungi germinate in the living economy of either vegetable or animal are very imperfectly known, and probably are at the first very trivially altered from the normal state; but once permit these minute bodies a footing, as it were, in the economy, and if retained at any one point or organ rather than another, from the rapidity of development, serious effects might be expected—(according to some botanists, cells in some fungi can be produced at the rate of 96,000,000 per minute, see Peunetier, 'L'Origine de la Vie,' p. 27)—lead to rapid decay in the cells and tissues, the formed material supplying the "dead organic matter" for their pabulum; then the secondary deposits may become deficient, and the catalytic changes induced by their presence so destroy the relation or balance of those efforts, at harmonic action, which are present in slight deviations from health, that increased sickness may follow.

That the protoplasm itself is converted into bacteria or fungoid germs is to me doubtful. In the petals of flowers, especially *Escholtzia*, some of the cells may often be seen filled with these moving bodies, supplanting the place of the normal plasma, gradually extending their domain into neighbouring cells and hastening decay; yet we are not in a position to say such germs were not introduced from without either by the spongioles of the rootlets or by the stomata. The duration of their life is also undetermined, and, if at all in proportion to the rapidity of their increase, must be short; but if originally reserved for ulterior uses, this may be reversed, and their power of resistance to increased temperature, &c., reach far beyond the point at which higher organisms perish. The cumulative evidence at present does not appear to sufficiently preponderate either way, to settle this controversial and difficult question.

V.—*Jottings by a Student of Heterogeny.*

By Metcalfe Johnson, M.R.C.S.

No. II.

Musing on the banks of a rivulet, we naturally ask ourselves the question, "Where, whence, and whither?" The stream alone can tell us, and in its ever-shifting ripples we see the image of the changing face of science.

The object of these jottings is to develope by record of experiment and observation some of the ripples on the great stream of scientific research which may tend to show its "Where, whence, and whither."

The observations in the following fresh records have been made by a power of from 250 to 300 diameters.

Of the existence of Monas Lens as an early form of protoplasm, whence many of the subsequent developments arise, evidence is shown in the experiments, March 5th, 1868, and May 25th, 1868; also in the observations on the birth of Monas in the first page of "Jottings," No. I., page 99, M. M. J., August, 1869; and in "Observation," April 28th, 1868, page 104, M. M. J.

Nov. 1*st*, 1869.—In Vaucheria Clavata saw a tubule bursting, and chlorophyll escaping, which consisted of transparent bodies (Monas?) having free spontaneous movement.

The single bodies transparent, the larger masses green.

Oct. 11*th*, 1866.—Six white glass bottles filled with water from an air-sieve had each three drops of a solution of Potassic Permanganate put into it, and showed, decolorization (when compared with distilled water) varying as the quantity of organic matter contained. The same water examined by the microscope revealed varying quantities of Monas Lens. Those in which decolorization was greatest showing the largest number of monads.

The following experiment, commenced July 21st, 1869, may be of interest:—

A piece of lint, placed in a Woulfe's bottle, long enough to syphon out the water, which was frequently renewed. Exposed to air. A drop of the water was subjected to the microscope with the following results:—

July 22*nd*.—A few minute oblong bodies, visible only by reflected light.

July 23*rd*—One or two starch cells. One Gonidium, and numerous small spots, some of which seem to change position very slightly.

July 26*th*.—No moving life.

„ 28*th*.—Large numbers of minute dots visible only by reflected light. Spontaneous movement evident (not currents).

Aug. 6*th*.—Undoubted monads.

„ 12*th* —Monads undoubted. Syphon has been dry some time.

„ 22*nd*.—No movements in monads. Several round and *oval*, green Gonidia.

Aug. 27*th.*—No moving life.

„ 29*th.*—Small patch of Chlorococcus. Cut it off, and found more than 100 cells of Chlorococcus. There are other green patches on the lint. Passed water from Woulfe's bottle through lint syphon to a wide-mouthed bottle, marked B.

Sept. 2*nd.*—No moving life in B.

„ 5*th.*—Monads rotating.

„ 10*th.*—Numerous monads. Motions in straight lines, in cycles, and rotating on their axis.

Put lint syphon into a small beaker filled with rain outside window marked G. No moving life.

Sept. 14*th.*—Surface of B. Thousands of *oval* cells.

„ 17*th.*—Monads. Some *active*, others still inclining to green colour.

Sept. 18*th.*—Fewer *active* monads, rather greenish. Side to light, small green Gonidia. Bottom larger *oval*, green Gonidia.

Oct. 8*th.*—Bottom—a large deposit of green chlorococcus.

„ 12*th.*—Vacuoles in chlorococcus.

Sept. 14*th.*—C. No monads; one piece of amorphous matter moving in a cyclical manner.

Sept. 17*th.*—Surface, very minute monads, as pin points; distinct movement.

Oct. 10*th.*—A large number of *still* transparent cells, granulated. A few *oval* green Gonidia; innumerable monads (as pin points); one transparent moving body (Paramœcium?); one oval cell, with septum in middle. Side to light. Green Gonidia.

Of Chlorococcus, see "Jottings," Exp., March 5, 1868; *d.* April 2; *f.* April 6 and 7; *g.* April 17, 23; and notes, May 20th.

January 30*th*, 1869.—Observed *white* Chlorococcus (Soridial) on a wall; passing to Thallus, one small Apothecium of Cladonia Pixid.; also, passing to Lecanora, subfusca, very evident.

July 27*th.*—*Green* Chlorococcus from wall, with small soridial tubes. *Grey* Chlorococcus; larger Gonidia; Soridial tubes larger, and in greater proportion.

Sept. 11*th.*—*Green* Soridium, passing to Thallus.

Sept. 24*th.*—Green Chlorococcus from wall, as if passing to Parmelia, some double, some quadruple cells.

Oct. 21*st.*—*Yellow* and *green* Chlorococcus from wall; no apparent difference in Gonidia, or in the mode in which they are arranged. Both in the Soridium stage.

Oct. 25*th.*—*Yellow green* Chlorococcus on pig-stye; distinct Apothecia. No Thallus.

Oct. 29*th.*—*Green* Chlorococcus passing to Lyngbya, on door of pig-stye.

Oct. 5*th.*—Chlorococcus and moss growing together on wall, single, double, and quadruple cells. Tubules, containing single rows of Gonidia (Lyngbya?). Larger tubules, containing many Gonidia in each vacuole. Single oval cells, containing many Gonidia. Branched filaments.

Oct. 6th.—Wall in my garden, Chlorococcus with Lyngbya; large single *oval* cells, with terminal vacuole like large Euglena (see Feb. 5, 1869—*Moss-cells*).

June 7th.—On the edge of a tumbler containing Mosses and Confervæ in water (one month) a green rim of distinct Chlorococcus.

June 12th.—Chlorococcus in tumbler containing Confervæ.

June 19th.—Water containing Confervæ, resting spores (Chlorococcus?).

July 28th.—On side next light of a bottle marked A, into which some Conferva rivularis was put (Nov. 9, 1868) are masses of round, green Chlorococcus. A floating film or frond near the bottom consists of smaller *oval*, green cells; no moving life. The bottle has a ground stopper in, and contains three-fourths water.

July 31st.—Green film on side (A); Chlorococcus, mixed with a few Mucedo filaments.

Sept. 2nd.—Each cell of Chlorococcus (side A) has a centre nucleus.

Sept. 5th.—The same.

Nov. 15th.—Cells from side A nearly all oval, and nucleated. A few straight, small-beaded filaments, as if still vibrions.

The following observations refer to *Palmella cruenta.* (See "Jottings," Aug. 20th, April 21st and 27th, and May 11th.)

June 18th.—On a damp wall, with every variety of green and red patches intermixed. Palmella cruenta and Oscillatoria containing red cells, monads, green, round, *oval*, and binucleated cells, congregated round cells as Chlorococcus, rudimentary and perfect tubules of Oscillatoria, larger green cells as of mosses inextricably intermixed with red Palmella cells, branched moss cells and moss tubules with vacuoles, containing numerous chlorophyll cells.

July 23rd.—Palmella cruenta, red and green cells inextricably intermixed, single, double, multiple cells of Chlorococcus, tubules of Lyngbya, with separate chlorophyll cells, larger moss cells, round, *oval*, and *oblong.*

Aug. 12th.—In stagnant water containing Confervæ is a red film, very small red globules in patches.

Sept. 3rd.—Similar observations. There are flat *green* Paramœcia, green Gonidia, all sizes; distinct Euglena.

Oct. 14th.—Palmella cruenta. Green and red patches inextricably mixed, in red part mostly red cells, a few green Gonidia, round and multiple; some *oval*, *oblong*, and perfect Oscillatoria. In green part larger Chlorococcus with oval cells; close to this is a perfect patch of Oscillatoria in all stages, from round to *oval*, *oval* to *oblong*, *oblong* to perfect tubules.

In observations on Oscillatoria, see "Jottings," May 10th and 11th, and April 21st.

Jan. 31st.—Green slime from canal bank, on moist mud, Euglena, common, and with vacuole; *oval*, *elongated*, and *perfect* tubes of Oscillatoria.

Jan. 31st.—Oscillatoria formerly Palmella cruenta, every stage from round green cells to perfect Oscillatoria. Tubules with separate chlorophyll (Lyngbya?).

May 21st.—Oscillatoria attached to moss.

June 3rd.—Oscillatoria from horse trough. On an iron tube adjoining, tubes with chlorophyll more distinct.

June 7th.—Oscillatoria from a running tap, Gleocapsoid double cells enclosed in transparent utricle.

June 22nd.—Green slime on a leaking tank, round, oval, and nucleated cells. Gleocapsoid double cells, Oscillatoria and tubules containing separated chlorophyll (Lyngbya?).

June 24th.—Surface of a stagnant pool which in a recent state would contain Euglena. A film of Oscillatoria filaments of every size from smaller to full-sized Lyngbya.

June 29th.—Oscillatoria from a dripping tap, with evident Lyngbya. Lyngbya containing moss tubules.

Sept. 5th.—On surface of green slime Euglena Oscillatoria and chlorococcus.

Sept. 25th.—Oscillatoria containing Lyngbya, moss tubules and branched tubes.

June 18th.—Oscillatoria and Lyngbya in the same patches at bottom of a wall.

Aug. 27th.—Lyngbya of every size, containing branched tubes of moss.

Of Euglena, see "Jottings," Exp., March 5th, 1868, and April 20th, April 15th, April 28th, Aug. 20th, May 4th, May 6th, May 10th, May 11th, 1868.

March 26th, 1869.—Euglena of all shapes and with vacuole, some becoming transparent, as if to pass to Convallaria.

April 11th.—In Conferva rivularis (April 9th) Monas freely floating in water, and very small Euglena with vacuole; after a few minutes saw from 50 to 100 perfect but small Euglena pass through a hole in the tube of Conferva rivularis, whose vacuole contained many more.

Oct. 25th.—A bottle containing 1½ drachm of citric acid, in 6-oz. water (14 days), contains Mucedo granules outside tube. Filaments small.

A bottle containing potassic nitrate and antimonic tartrate in 6-oz. water (10 days) contains Mucedo granules inside and outside tube. Larger filaments

½ inch air in each bottle, corked and tied over.

A bottle containing plumbic acetate one month. No Mucedo.

A bottle containing hydrargyric bichloride six months. No Mucedo.

A bottle containing Liq. Bismuth six months. Round plants of Mucedo.

Of Vibrio, see "Jottings," Part I., Exp., March 5th, 1868; *g.* April 13th, 15th, 17th, 21st.

Sept. 17th, 1869.—Water containing green slime from a stone pavement near a running tap (Sept. 13th). Masses of germinal matter, composed entirely of Vibrions. Central Vibrio still; free at edges, moving at intervals. When the water evaporates the Vibrions appear like beads.

Sept. 19th.—Another observation of Vibrions from same source, counted 40 links in one chain. Vibrions bead-like when dry.

Oct. 25th.—Observed the mucilaginous exudation from Palmella cruenta (Oct. 13th). Found no Vibrions; only still granular matter.

Aug. 23rd.—Put up some Pulv. Tragœ co., with warm water in the following states:—

α oz. $\frac{1}{2}$ in bottle a bubble of air. In darkened room.
β oz. $\frac{1}{2}$ in 1 oz. bottle. Half air. ,, ,,
γ 1 oz. in 2 oz. bottle. No cork. In light.

Aug. 24th.—No change in γ.

,, *27th.*—A scum on surface of γ. Small bodies. Movement uncertain.

Aug. 29th.—Filaments of Mucedo on surface of β.

,, *31st.*—No moving life in γ.

Sept. 18th.—No moving life in γ or β.

Of Paramœcium, see "Jottings," Exp., March 5, *b*. April 17th, 20th; *d*. March 10th, 17th, 20th, 26th. Exp., May 25th. E June 1st, 3rd, 9th; May 30th. Observations, April 15th; May 6th, 11th, 20th, 23rd; April 17th, 21st.

May 9th, 1869.—Observed several globular and oval Paramœcia with projecting globular cells, which, when knocked about by other Paramœcia, were liberated; no spontaneous movement.

Saw the vacuole in a Paramœcium change its situation, and then slowly change to a form as if about to separate bilaterally.

Watched a Paramœcium divide into halves.

Saw a Paramœcium with bifurcated tails (?).

Watched the change in position of the vacuole, and afterwards a side view, by which I could decide that the change of vacuole is due decidedly to contraction of cell-wall. See April 15th, "Jottings," No. I.

July 25th.—Saw two globular Paramœcia from the surface of a liquid containing mosses and confervæ conjugated for about a minute, and then separate.

Saw the contracted cell-wall again from a side view.

Watched Paramœcium globular, oval, and squamous so associated with Convallaria of all shapes and forms, that they seem to be the same in different stages of development.

August 9th.—Put some grass seeds in an open tumbler of water.

Aug. 10th, 2 P.M.—Evident Monads, Vibrions, and Mucedo.

Aug. 12th.—Surface full of Monads and Vibrions.

Aug. 27th.—Paramœcia of all sizes; Convallaria innumerable.

September 13th.—Put up two patches of green slime from a pavement—one near a running tap, where the stone was rough, marked T; the other from near a sink where the stone was smooth, marked S; each in two drachms of water. T contains Chlorococcus patches—round, oval; links of two or three, and Oscillatoria tubes; no moving life. S contains Chlorococcus patches, round, and separate soridial tubules; no moving life.

Sept. 17th.—T contains yellow Diatoms and green Chlorococcus. S contains single granulated monads, double and multiple, all moving. Paramœcium and Convallaria. Watched a round, transparent cell containing about ten green globules, throws out a projecting ciliary apparatus, and becomes a Convallarium. Watched a globular Paramœcium gradually separate into two, which finally were attached by a *tubular link* before separating; when they separated, one retained the globular shape, the other became oval; each then floated away as an independent plant.

Examined the filament, or stalk, of a Convallarium which had a motion from side to side, *independent* of the body.

Examined the main contents of the drop of liquid S, and found monads of every size, free and in clusters, all moving over the others, some in masses of about ten *oval* cells; cells rotating on their own axis. *Oval* cells, large Paramœcium of every shape and stage, conjugating, separating, ciliated, and non-ciliated; in fact, every variety intermixed with Convallaria.

Sept. 18th.—Paramœcium is only a stage of growth of Convallarium.

Saw a distinct Convallarium, with filament attached, swim off, exactly as a Paramœcium.

Saw Paramœcium change to Convallarium, protrude a tail, filament or stalk, and throw out cilia in front.

Watched a Paramœcium for five or six minutes, saw the whole change of fissation from one oval individual to two globular.

Watched several Paramœcia with Convallaria arrangement of cilia under the influence of opium, changing the situation of the vacuole, and protruding a globular film of transparent membrane, like a bubble of air half its own size, above the cilia.

Sept. 19th.—There is no longer any doubt that Paramœcium and Convallarium are stages of the same thing. I have seen the same object assume four distinct forms—three distinct Convallaria and one equally distinct Paramœcium.

These observations were all made in the liquid marked S.

Of the cells observed in mosses.

Feb. 7th, 1869.—A number of round green cells, each having a prolongation consisting of a vacuole, generally containing one or more green masses. The cells presented a great variety of very beautiful shapes.

June 18th.—Found some *branching* moss-cells in a patch of Palmella cruenta.

June 22nd.—Every variety of Moss-cells, from round and oval to elongated filaments, found under a board at a boat landing-stage on the river Lune.

Of Diatoms.

June 10th —Examined some specimens of Marine Algæ, in which the vacuole varied in size, from filaments containing globular masses of chlorophyll to those containing elongated and paler masses; others containing two rows more closely arranged, and containing from five to ten or more rows of chlorophyll; smaller fronds branching, of a similar arrangement of chlorophyll cells.

August 10*th*.—Similar Algæ from the side of a boat taken out of a tidal part of river Lune.

October 21*st*.—Specimens of Algæ with innumerable diatoms of various kinds, in which the green cells gradually pass from the square to an elongated shape. Other tubules from the same plant are full of diatoms, having brown cell contents. Tubules in which the diatoms have some green and some brown cell-contents, evidently stages of the same plant.

Nov. 4*th*, 1869.—Examined the Alga containing diatoms, various forms of the same plant, single tubules containing rounded masses of chlorophyll, elongated vacuoles containing irregular masses of chlorophyll, double rows of small chlorophyll cells. Single rows throwing out branches; multiple rows throwing out branches; tubules in which one part contains masses of chlorophyll, and a contiguous broken end containing single diatoms, or double cells; green tubules composed of evident double cells; crushed portion composed of double cells (green), isolated double cells (green), aggregated transparent cell-walls, without chlorophyll.

The double cells (green) have the same movements as diatoms containing yellow and brown contents. Crushed a portion of one of the larger tubes and found it composed of double cells, having green and light-brown contents, evidently stages of growth of diatoms; watched the movements of diatoms green and yellow in the currents of evaporating water, and found the various forms due to different facets being presented to the view.

Nov. 8*th*.—Further examined the diatoms, and found transitional forms from green to brown. Their source in this case is evidently in the cell-walls of the Alga; some are free within the vacuole, while others appear to form the mass of the Alga, bound together with transparent soridial membranes.

VI.—*The Mode of Examining the Microscopic Structure of Plants.* By W. R. M'Nab, M.D. Edin.

The description of the modes of examining the microscopic structure of plants can best be given by considering each tissue separately. Let us, therefore, first give a few brief remarks on the tissues themselves; then proceed to mention the plants best adapted for demonstrating the different tissues, and describe the methods suited to the display of the peculiarities of each tissue. The division of the tissues of plants into the two great divisions of *cellular* and *vascular* can hardly be considered sufficient for our purpose, and much confusion results in considering all the tissues of plants as referable to these two divisions. For example, Laticiferous vessels and Resin canals are best considered by themselves. Again, the whole of the external or Limitary Tissues of plants can best be considered as forming a great group, including Cuticle, Epidermis, Hairs, Scales, Cork, Subepidermal tissue, &c. The group of tissues found in the Fibro-vascular bundles of plants can also be advantageously studied as a whole. In the Arrangement of the Tissues we shall follow, to a certain extent, Sachs,* as he enters very fully into the subject. We shall first consider Cells and Cellular tissue; then the Limitary tissues of plants, including Cuticle, Epidermis, Hairs, &c., the Fibro-vascular bundles, and, lastly, the Laticiferous tissues and glands. If we begin by examining a young root, such as that of the white mustard, we can at once see the relationships of the various groups of tissues. If we take a transverse section of a young root, and place it under the microscope, we see three separate tissues. Externally, we have the Limitary tissues, consisting of small epidermal cells, giving rise to numerous fine hairs. Within the limitary tissues we have a great mass of cellular tissue, and in the centre we have the fibro-vascular bundle more or less developed. In many plants we have the Laticiferous tissues developed, but they are in general altered portions of one or other of the tissues, and not a separate group; but as they are easily distinguished physiologically, it is perhaps best to keep them separate. If we examine the growing part of the root, we find that the tissue presents a uniform appearance, all the cells being similar, and it is only as growth goes on that the cells become variously modified to subserve various physiological purposes. Some of the cells became modified to form a protecting covering; others to give support to the softer parts, to form a skeleton, or a series of conducting tubes for the conveyance of the sap and juices of the plant, while others may contain stores of nutriment for the future use of the organism.

I. *The Cell.*—If we examine the cells of the growing point of a root, as seen, for example, in a longitudinal section of the young root of the white mustard, after tinting with carmine solution, we see a number of small cells, consisting of a very delicate cell-wall, containing a mass of granular protoplasm, and a very large brightly-stained nucleus. In the youngest stage the cell thus consists of three parts:—1st. A very delicate cell-wall; 2nd. A mass of granular protoplasm; and 3rd. A very large central nucleus. If we examine the cells at a short distance from the growing part of the root, we find that the cell-wall has enlarged, in general growing more in length than in breadth, but consisting of the same parts as those at the apex. Further away still we find that drops of fluid are forming in the protoplasm; that the cell-wall is no longer filled up by the protoplasm and nucleus alone, but there are also drops of cell-sap beginning to form. If the cell in this

* 'Lehrbuch der Botanik.' Engelmann. Leipzig, 1868.

condition be treated with a dilute solution of Iodine and Iodide of Potassium the protoplasm is coloured brown, and the drops of cell-sap can be very distinctly seen. In making observations on the young cells of plants, it is of great importance to select plants which contain little or no starch. All the observations above mentioned can be made in the roots of the garden pea, but the quantity of starch in the cells greatly obscures the clearness of the demonstration. At the stage now reached, the cell consists of the thin outer cell-wall, the protoplasm with the nucleus, and a few central drops of cell-sap. The nucleus is soon pushed aside, but always remains imbedded in the protoplasm. As the cell grows, the cell-sap occupies more and more space until at length the whole central cavity of the cell becomes filled with cell-sap, the protoplasm forming a layer in close relation to the cell-wall. The nucleus has now been so pushed out of its place that it is apparently adherent to the cell-wall. This can be well seen in the roots and stems of many Monocotyledons. By means of dilute acid you can separate the thin layer of Protoplasm and the nucleus from the cell-wall. This condition of the protoplasm was described by H. Von Mohl as the Primordial Utricle. The next stage in the life of the cell consists in the almost total disappearance of the protoplasm nucleus and cell-sap. The last stage of all is characterized by the entire disappearance of cell-sap, only a series of dry cell-walls being left, which can be well seen in the pith of many plants. The Histological Characters of the cell are thus seen to differ at the various stages of its growth. We may consider the perfect cell as consisting of a cell-wall, protoplasm and the nucleus, and the cell-sap. It is, however, only at those places where growth is actively going on that we find cells presenting these characters; the great mass of a plant consists of cells, with the primordial utricle and nucleus, or merely of dry cell-walls.

Having thus considered the cell as being made up of three distinct parts, we must now examine each part a little more in detail. The examination of the cell-wall would lead us to consider the various forms which cells assume during the process of growth; these modifications suiting them to their several positions in the structure of the plant, or adapting them to the performance of some definite and special function. Besides variations in the form of the cell-wall, the most important change which occurs during the process of growth is *thickening*. This thickening may be regular or irregular, external or internal. In most cases the thickening is internal to the primary cell-wall, but in a few cases the thickening is external. In the case of pollen grains and spores the inner layer, the Intine or Endosporium, seems to correspond to the primary cell-wall, while the Extine or Exosporium is an external thickening layer. Almost every variety of external thickening is to be met with in pollen grains, some of them presenting very remarkable appearances. In others the external thickening may be undeveloped, as for example in the pollen grains of *Zostera*, in which the outer covering, the Extine is wanting. By far the most familiar examples of thickening are to be found in the interior of cell-walls. Take, for example, wood cells. Here we have a very good example of thickening, or in the hard cells of certain fruits. This thickening in the interior of cells may be either regular or irregular, but in by far the most numerous cases the thickening is irregular. Certain parts of the primary cell-wall become more or less thickened, while at other parts the cell-walls remain unchanged. The familiar examples of spiral deposits and annular rings of thickened matter are well known to most observers. In some parts we have more or less marked spiral fibres apparently coiled up in the cell. This is a thickening deposit, but it is so loosely attached to the primary cell-wall that in many cases it can be very easily detached from the cell-wall. The same may be seen in cells containing annular rings. These may be in some cases quite easily detached, and may even be found loose in the cell by which they are formed. Often we have these different forms of thickening combined, thus forming cells the walls of which may be partly annular, partly spiral, or reticulated in various ways. These varieties of cells can be very easily obtained, and many plants, such as balsam, asparagus, rhubarb, Indian corn, &c., may be used to demonstrate them. The cells containing thickening deposits can often be isolated by boiling in nitric acid. Boiling in nitric acid has, however, the disadvantage of rendering the parts yellow, and often exercising a very considerable solvent action where it is not wanted. Many beautiful preparations can be got by boiling thin slices or even thin parts of plants in caustic potash. This renders the tissue more transparent, without destroying the clearness of the thickening deposit. In this way beautiful demonstrations of the elongated spiral cells of certain plants can be made, the spiral cells standing clearly out among the transparent tissues in which they lie.

Many of the examples of irregular thickening occurring in the inside of cell-walls are very curious and interesting. In the epidermal and sub-epidermal tissues of plants we have some very remarkable examples of thickening. In many of these cells the thickening only occurs at those parts where neighbouring cells meet. These angles or corners seem to be strengthened by the addition of a sort of buttress of thickening matter. In the petiole of Begonia this thickening can be well seen in patches at the corners. In the petiole of the Ivy the same thing is observable, but the thickening has gone on to such an extent that it requires some little care to show that the deposit is not uniform, and that it really has had its origin at the corners of the cell, and extended to each side. Porous and pitted cells are also familiar examples of partial thickening. In some cases the cell-wall becomes absorbed, and a channel of communication between the cells is formed. If we have thickening occurring at certain parts of the cell-wall, resembling a porous or pitted cell, and if the primary cell-wall, which is not covered by thickening matter, becomes absorbed, then we have the peculiar cribriform cells formed, such as are to be seen in the stem of the white gourd (*Cucurbita Pepo*). These cribriform cells form a connecting link with the punctated tissue of the conifers and ordinary porous or pitted cells. In the Coniferæ we have the thickening deposit leaving rounded patches of the primary cell-wall uncovered. As the thickening goes on the thickening matter extends in and in, until a cavity, shaped like a plano-convex lens, is formed, and leaving a small round centre-spot free from thickening matter. The same thing takes place on the other side of the cell-wall; so that, when the small portion of the primary cell-wall becomes absorbed, we have a cavity, shaped like a double-convex lens, formed, and the cavities of the two cells freely communicate with each other. We see examples of a very similar process in the tuber of the Dahlia, and still better in the scalariform tissue of Ferns. In ferns we have a tissue formed in the same way as the punctated tissue of the pines, with this difference, that in the pines the dots are circular, while in the ferns the portion of primary cell-wall left uncovered is elongated, the thickening occurring in bars, resembling the steps of a ladder: hence the name scalariform given to the tissue.

In some cases the thickening deposit in the interior of cells may be made up of layers of different appearance. This is to be seen, for example, in certain cells in the stem of the Common Bracken, where we have the primary cell-wall and two differently coloured layers of thickening matter inside. Besides differences in appearance, we may have chemically different substances deposited in the thickening layers of the cell-wall. Take, for example, the Charas and Diatoms. In these we have mineral matter, as carbonate of lime and silica, deposited in the cell-wall. There are many other examples of silicious matter deposited in cells besides the diatoms. The silicious matter deposited in the cells of the cuticle of the Equisetums, and in the cells of grasses, &c., is familiar to most microscopists. In general the primary cell-wall remains very thin, but in certain instances—as, for example, in the cells of certain sea-weeds—the primary cell-wall becomes greatly thickened, a sort of gelatinous degeneration occurring in it. We see the same thing in a few cells of the endosperm of the Locust-Bean. In these cases the primary cell-wall has been described as intercellular substance. This intercellular substance has given rise to a great deal of dispute, and much has been written on the subject. Many authors have held that this substance which joined the cell-walls together formed on the free surface of the plant what we call the cuticle, and therefore considered that the cuticle and intercellular substance were identical. There does not, however, seem to be any intercellular substance, what has been described as intercellular substance being an altered condition of the primary cell-wall. The cuticle, on the other hand, is a thickening layer found on the outside of the cell-wall, and in this respect similar to the Extine of the pollen grain and the Exosporium. The use of the carmine staining solution shows this very conclusively, as the cuticle can be very easily stained, while the so-called intercellular substance remains intact. Having thus briefly discussed a few of the more important points to be attended to in the examination of the cell and cell-wall, we shall in our next proceed to the examination of the Protoplasm, Nucleus, and Cell-sap.

(To be continued.)

VII.—*On the Microscopical Examination of Milk under certain Conditions.* By J. B. Dancer, F.R A.S.

In August and September last an account appeared in one of the newspapers (and also in other periodicals), which had been copied from the 'Journal des Connaissances Médicales,' of some microscopical observations made by M. V. Essling on Milk, in which the author stated that "if the surface of fresh cream be examined under the lens, one perceives, amid myriads of milky and fatty globules, a number of either round or oblong corpuscles, sometimes accompanied with finely dotted matter, being neither more nor less than germinative masses of vibrios—just what is seen in most substances in a state of putrefaction In summer these corpuscles make their appearance within fifteen or twenty-four hours after milking; in winter they will be perceptible after the lapse of two or three days. If the observation be continued until the moment of coagulation we see these corpuscles increase in number, bud, form ramified chains, and at length be transformed into regular mushrooms or filaments composed of cells placed end to end in simple series, and supporting at their extremities a spherical knob filled with granulous matter. M. V. Essling thinks that they may be classified among the Ascophora. But the important point is, that the first appearance of these spores occurs *before the milk gets sour*, and as this substance is almost the exclusive aliment of children, there is reason to suppose that many of the gastric affections to which they are subject are-owing to this state of the milk. To prevent these evil consequences, M. V. Essling recommends the milk to be drunk as soon as possible after extraction, and at all events to keep it closely bottled during the interval, so as to keep out the smallest particle of air. Moreover, the temperature should be kept as nearly as possible the same as that which the milk had in the teats."

Having for many years been familiar with the microscopical appearance presented by milk and cream, and not having seen the changes as described by M. V. Essling, I was desirous of satisfying myself on this point, more especially as it affected a very important article of food. The composition of ordinary milk, as stated by Fownes, is as follows:—

Water, 873·00; butter, 30·30; casein, 48·20; milk sugar, 43·90; phosphate of lime, 2·31; phosphate of magnesia, 0·42; phosphate of iron, 0·07; chloride of potassium, 1·44; chloride of sodium, 0·24; soda in combination with casein, 0·42: total, 1000·00.

Composition of casein in 100 parts:—Carbon, 53·83; hydrogen, 7·15; nitrogen, 15·64; oxygen and sulphur, 23·37: total, 100·00.

Composition of albumen in 100 parts:—Carbon, 53·5; hydrogen, 7·0; nitrogen, 15·5; oxygen, 22·0; phosphorus, 0·4; sulphur, 1·6: total, 100·00.

Casein and animal albumen are remarkably similar in composition; casein differs in not being coagulated by heat, and is precipitated by acetic acid. Certain animal substances cause its coagulation, such as the dried stomach of the calf, known as rennet, used in the manufacture of cheese.

When a thin film of milk is examined with the microscope, it is found to be a transparent fluid, in which are floating numerous transparent globules of fat; these are surrounded by a thin pellicle, and when this pellicle is broken mechanically, as by churning, the fat is liberated and forms butter. The fluid part consists of casein, saccharine matter, and salts in solution. The proportion of these organic principles varies in different animals, and also in the same animal when well fed under different conditions. Human milk usually contains a larger proportion of sugar than cow milk, and is coagulated with greater difficulty. It is well known that the secretion and quality of milk is influenced by the mental emotions. Milk as obtained in towns is frequently adulterated, and as foreign matter would alter its microscopical characteristics, it was necessary to procure pure milk. One of the members of the Literary and Philosophical Society of Manchester, Mr. Kipping, kindly supplied me with a bottle of fresh-drawn milk. The cow had calved about three months previously, and had been fed on grass, bran, and bean flour. This milk was examined soon after I received it, and was found to be very rich in oleaginous globules, forming a plentiful supply of cream. There was no appearance of dotted matter or any fungoid growth when examined by powers varying from 200 to 1500. The smallest oil globules exhibited (as usual) great molecular activity. A bottle was filled with some of this milk and securely corked, other portions of the milk were placed in open cups, one cup was kept in a cabinet which was closed during the day, the milk of the second cup was placed in a closet the atmosphere of which I knew to be favourable to the growth of fungi, the Mucor Mucedo being the most abundant and of the same family as that mentioned as having been found in cream by M. V. Essling. The milk in the bottle and that in the cups was examined daily, precautions being taken to close the bottle speedily after a portion was removed. On the third day the milk in the open cups was sour to the smell, but no change appeared visible under the microscope; the upper portion of the milk in the bottle had become very rich in oil globules by the formation of cream. On the fourth day the casein had coagulated in the milk in the open cups, and the flaky precipitate was visible under the microscope; the pellicle surrounding the oil globules now appeared to be very easily ruptured, and with the slightest pressure some of the globules could be joined together—sometimes a number of globules which had been ranged in line by a current would coalesce by a slight movement of the fluid, and form an elongated mass. Fifth day, no appreciable alteration. Sixth day, the milk which had been placed in the closet had patches of mould visible on its surface; a microscopical examination of this mould showed it to be the Mucor Mucedo, such as I had frequently found on fruit which had been left in this closet. The fungi appeared on the surface only, no trace of it could be found in the milk taken from various depths. The milk in the cup kept in the cabinet exhibited no appearance of the Mucor Mucedo or any other vegetable or animal organism; it had become thickened into a pasty mass with an intensely sour odour. These observations were continued for eleven days, and the only difference observable was in the oil globules—they began to lose their spherical form, as if the investing pellicle had been weakened in parts and had become expanded.

These experiments were repeated with a second supply of milk which Mr. Kipping kindly supplied, and the results were alike in both cases. The range of temperature during the experiments was from 45° to 63° F. These experiments would lead me to believe that vegetable organisms do not as a rule make their appearance in pure unadulterated milk unless it is exposed for some time to atmospheric influences; most probably the spores are supplied by the atmosphere. Further experiments are wanting to decide the question. The microscopical examinations should be continued in hot weather. I hope to be able to resume the inquiry next summer under different conditions, which have suggested themselves during the examinations I have detailed. In any case M. V. Essling's suggestion to bottle the milk is very good, and in my opinion cream pans with covers would be a very great improvement on the open ones as at present employed, at the same time having due regard to the cleanliness of the apartment and vessels in which the milk is kept.

In a microscopical examination such as I have recorded it is quite necessary to have pure materials. The milk as supplied by vendors we know to be very frequently adulterated, and the most simple and easy method is by the addition of water. We know also that in towns where the water has a high character for purity, it sometimes happens in dry hot weather the reservoirs are charged with vegetable and animal organisms. Milk may not always have town's water added to it; in this case there may be an extra quantity of vitalized matter introduced. What a surprising account a microscopist might furnish from the examinatien of milk containing such an importation! In the cold weather, such as we have at present, animal organisms are not so abundant, and this may account for their absence from a sample of milk obtained in this town, in which I found algæ, but not belonging to the pure milk. One curious circumstance was noticed in this milk, no Mucor Mucedo appeared in or on it, although exposed in the closet for the same length of time as Mr. Kipping's milk, which showed signs of this growth on the sixth day, and on the twelfth day the town milk had none visible. I may mention that pure milk in a bottle securely corked remained fresh twelve days; possibly the low temperature favoured its preservation.—*A Paper read before the Literary and Philosophical Society of Manchester*, Nov. 30th.

NEW BOOKS, WITH SHORT NOTICES.

The Anatomy and Physiology of the Blow-fly (Musca Vomitoria). A Monograph by B. T. Lowne, M.R.C.S. London: Van Voorst, 1870. —It would be impossible for us to give too high praise to this excellent work, which, as the author styles it, is indeed a monograph on the blow-fly. Microscopists generally are disposed to look upon a blow-fly as an insect which contains a proboscis that makes a handsome object for exhibition under low powers. But Mr. Lowne does not belong to that category: he is one much more akin to those German histologists who devote themselves so assiduously to describing all that is known on a certain subject. In this path Mr. Lowne has followed, and in the 120 pages of this work, and the ten well-executed plates which accompany them, he has told us nearly everything that is to be told of the anatomy of the familiar insect on which he has written.

It is hardly necessary to remind our readers that Mr. Lowne's work is not simply a compilation from other works: it is a book in which the author sets down all his own careful observations conducted during a series of years, and in which he also describes the work of other students, and analyzes the current doctrines on the subject of dipterous histology. As an indication of the elaborate character of the book, we will quote the headings of the different sections into which it is divided, these being grouped under the two divisions of general and minute anatomy. These are as follow:—Development, Integument, Nervous System, Wings and Legs, Digestive System, Respiratory System, Fat Bodies and Ductless Glands, Organs of Special Sense, Generative Organs.

The foregoing are the sections which deal with the general Anatomy and Physiology. These are the headings under which the special anatomy is treated upon:—Integument of Head, Proboscis, Salivary Glands, Alimentary Canal and Appendages, Rectal Papillæ, Integument of Thorax, Thoracic Appendages, Abdominal Segments, Respiratory Organs, Dorsal Vessel, the Nervous System, the Compound Eyes, the Ocelli, the Antennæ, the Maxillary Palpi, the Frontal Sac, the Cephalo-Sternum, the Halteres and Wing Organs, the Folliculate Glands, the Male and Female Generative Organs, the Development of the Ovum, and the Formation of the Pupa. It would be impossible, in the mere space of a notice, to criticize any of the author's views, but we may express a belief that from the very decided tone in which certain views are laid down, that Mr. Lowne will draw upon him the controversial pens of other workers. We see this sort of thing illustrated here and there throughout his admirable book. In the case of the so-called ductless glands, for instance, it is well exemplified. The author having described one of the glands, says, "From the great similarity of the contents of these follicles to those of the spleen and other ductless glands in the Vertebrata, *I have not the slightest doubt* as to the similarity of their functions, which is the elaboration of the circulating fluid." This is dogmatic. Without pausing to consider what is meant by the vague expression elaboration of the blood, we would just remind Mr. Lowne: firstly, that the follicular glands he describes bear a very remote resemblance to either the spleen or the thyroid; and secondly, that physiologists are by no means decided as to what the office of such bodies as the lymphatics, Peyers glands, the tonsils, the supra-renals, thyroid and thymus may really be. Absolutely we know nothing at all of their functions.

Mr. Lowne's account of the integument is full of interest; and though he would assume that it is developed in a manner different to that of the ecderonic and enderonic layers of other invertebrates, we fancy his facts lead to an opposite conclusion. We would raise our voice against his introduction of a new terminology simply applicable to one insect. We wish we had more space to explain to our readers the many excellences of this work; but we must now conclude with hearty thanks to the author, and with our advice to all who have a microscope to make the acquaintance of this volume without delay.

Untersuchungen zur normalen und Pathologischen Anatomie der Froschaut. Von Herrn D. Eberth. Leipzig: Engelmann.—This is more a work for the physician than the ordinary microscopist. It is an effort on the part of the author to describe a series of microscopical pathological researches. He has selected the skin of the frog, and has recorded some interesting results as to the origin of morbid growths.

Handbuch der Lehre von den Geweben des Menschen und der Thiere Herausgegeben. Von Prof. Stricker. Leipzig: Engelmann.—The first part of this work was briefly noticed in one of the early numbers of our first volume. The second is now issued, and is chiefly interesting from a paper of Herr von Recklinghausen on the Lymphatics.

Das Mikroskop und Seine Anwendung. Von Herrn H. Hager. Berlin: Springer, 1869.—This volume is, we believe, thought a good deal of in Germany. We cannot, however, give it much praise. It is too small, and its accounts of important matters too desultory to admit of our recommending it to English readers, who have such excellent treatises at their disposal.

Der Bau des Menschlichen Körpers, etc. Von Dr. C. Aeby. Leipzig: Vogel, 1869.—The first and second parts of this work have been been issued. The book is chiefly an anatomical one; its plan being somewhat like that of the excellent treatise of Quatin and Sharpey. Like the latter it includes an account of microscopic structure; but, unlike it, this account is of a very elementary and unsatisfactory nature.

PROGRESS OF MICROSCOPICAL SCIENCE.

The Microscopical Structure of Meteorites.—A paper to which we some time since referred, "On the Structure of Meteorites," by Professor A. Kenngott, of Zurich, and which was read in May last before the Vienna Academy, has been reproduced in the 'Philosophical Magazine' for December, and is accompanied by a handsome plate, representing the appearance of different sections of the Knyahynia meteorite. The structure, says the author, reminds one of the globular diorite of Corsica, and may therefore be supposed to be the result of a process of crystallization within its own substance rather than the aggregation of separately-formed corpuscles. The opaque components are light-grey' metallic iron, greyish-yellow magnetic iron pyrites, and a black substance. These three may best be seen by incident light when placed under the microscope. If the light from above is stopped, they all appear black by transmitted light. If light from above be admitted, only the black substance appears opaque, the iron appearing dark-grey and translucent, and the pyrites blackish yellow and faintly diaphanous by the effect of reflected light. In some parts a peculiar network of the transparentmineral substance presents itself. On the whole, the paper gives us the idea that there is in meteorites a field of microscopical research not at all exhausted by the author.

The Structure of certain Hailstones, though not exactly microscopical, is nearly so. It is a paper by M. Abich, illustrated by a plate, in the same number of the 'Philosophical Magazine' as the above.

Foraminifera of the genus Trochammina. — Messrs. Rupert Jones Parker and Kirkby continue their papers "On the Nomenclature of the Foraminifera," and in their last paper they give an account—with figures—of the Permian *T. pusilla* and its allies. The descriptions are too detailed for abstract. The authors do ample justice to the labours of Professor W. King, whose memoirs on Permian fossils are familiar to geologists. The history of the genus, from the time when it was first noticed twenty years ago, and when it was considered—by all save King, who recognized its relation to Rhizopoda—to be an annelid organism, to the time when its true affinities were established, is clearly stated.—'Annals of Natural History,' December.

The Development of Sorastrum, and on a new species of Protococcus is the title of a most valuable paper by Mr. Henry J. Carter, to the December number of the 'Annals.' The paper is a long one and deserves the careful attention of those interested in the study of the lower vegetable organisms. The author thus summarizes his observations in the first part of his paper. (1) The development of *Sorastrum spinulosum* commences by a division of the sporangium into sixteen portions or family groups of eight individuals each. (2) After elimination, these groups increase in size but not in number of individuals, so far as my observation extends. (3) Certain individuals produce one or more family groups, of eight, sixteen, or thirty-two individuals each, in cells respectively provided by the parent, which are deciduous (that is, subsequently soon disappear). (4) Those individuals of the parent group which do not produce new families, retain their gonimic contents, increase in size, become globular, and lose their spines by atrophy. (5) A spherical or slightly elliptical sporangium, about twice the diameter of the largest individual of a group of *Sorastrum*, makes its appearance, presenting a deep, dark sea-green colour, precisely like that of *Sorastrum*, composed of a tough transparent coat, filled with the usual contents of a sporangium, and surrounded by a thick, soft, transparent, gelatinous envelope. Since writing this summary Mr. Carter has established that fissiparity exists. The new species of Protococcus was found by the author in one of the tanks of Bombay before he left India. He has figured, it and calls it *Conococcus elongatus*.

Algæ enclosed in Diamonds.—Herr Dr. Göppert alleges that certain diamonds contain algæ enclosed in them. He has examined specimens in the Berlin Museum and in the British Museum. In both he has detected greenish, round corpuscles, which he regards as unicellular algæ. In one case he considered the species to be like *Protococcus pluvialis*, and in another to resemble *Palmoglœa macrococca*. He has given distinct specific names to the two, however. An account is given in the Report of the Imperial Geological Institute of Vienna for August 31.

The Muscular Fibres of the Ventricles.—Dr. P. J. Hensley makes some interesting remarks on this subject *à propos* of both Henle's and Pettigrew's researches. The paper, however, is more physiological than histological.—'Journal of Anatomy,' November.

The Chemical Constitution of the Nuclei of the Blood-Corpuscles is a *minute* (!) chemico-histological inquiry by Dr. Brunton, reported in the same journal.

The Spectroscopic Examination of Coloured Fluids is an admirable paper by Mr. E. Ray Lankester. It is an abstract of his voluminous report to the British Association, and has a woodcut showing the absorption of various substances, and also the lines of the scale formed by using the *nitric oxide gas.*—'Journal of Anatomy,' November.

A Diaplasmatic System of Vessels.—Dr. T. A. Carter publishes in the 'Journal of Anatomy' a paper which he sent to the Royal Society in 1864, and which that body considered worthy only of a short abstract in its Proceedings. Dr. Carter has attempted to prove what all experienced histologists surmise, *viz.* that the capillaries communicate with a fine reticulation of vessels, which are not large enough to admit the blood globules. Anyone who has ever measured the diameter of some of the fine German transparent injections of the brain must admit the existence of these channels, which it may be suspected are occasionally mistaken for lymphatics.

The Structure of the Siliceo-fibrous Sponges. — Dr. Bowerbank has published a splendid memoir on this subject, in Part I. of the 'Proceedings of the Zoological Society' for the present year. This is illustrated by a number of beautifully executed plates by Lens Aldous, and occupies about forty pages. The whole anatomy, both microscopic and general, and the zoology of the group are dealt with minutely, and the paper will be well worth reading even by those who do not make sponges a study. The subject is especially interesting just now, because so many curious forms of sponge have been taken up in the Atlantic expedition. The author strongly condemns the nomenclature proposed by Professor Wyville Thomson, and makes the following remarks on the subject :—"Dr. Thomson, in his highly imaginative paper 'On the Vitreous Sponges,' has not only proposed a new and very impracticable order for their reception, but he has also, contrary to all the established canons of nomenclature, proposed to abrogate the established generic names of the working naturalists, who have preceded him in writing on the Siliceo-fibrous sponges; and after contrasting the differences of opinion very freely, he at once proposes that they shall be all abolished, and his newly concocted name *Habrodictyon* be established in their stead. If the new name were illustrative of new ideas or of new facts, it might be entitled to consideration, but as we find neither the one nor the other in the learned Professor's paper, I do not think he can reasonably expect that it will be adopted."

The Investigation of the Lymphatics.—Dr. G. Schwalbe has a long and important paper on this subject in Schultze's *Archiv.* He deals especially with the Lymphatics of the eye. His remarks are especially of import, because they show that Von Recklinghausen's method of using nitrate of silver has certain disadvantages as well as advantages. His illustrations show how the staining process may lead us sometimes to incorrect inference. The paper occupies over sixty pages.—Schultze's *Archiv*, Band 6, Heft 1.

The Lateral Line in Fishes.—Herr Franz Schultz has published a very elaborate memoir on this subject. He gives numerous excellent illustrations, and traces out the connection between the organs of the lateral line and the fine terminations of the nerves. He refers to the labours of Dr. Robert MacDonnel, whose first paper in the 'Transactions' of the Royal Irish Academy our readers are perhaps already familiar with.—Schultze's *Archiv*, Band 7, Heft 1. Among other papers in this journal, we may mention one by Herr J. Dogiel "On the Dilator Pupillæ of Mammals and Birds;" and by Dr. Mayer, "On the Termination of the Nerves in the Salivary Glands," *à propos* of Pflüger's views.

The Larval State of Euphausia is a paper of interest in Siebold and Kölliker's *Zeitschrift*, by M. Metschnikow, of St. Petersburg.—*Vide* S. and K., *Zeitschrift*, Band 19, Heft 4.

Observations on the Rotifera.—In the above-mentioned journal will be found a paper of great interest to microscopists "On the Wheel-animalcules," by Dr. H. Grenacher, of Würzburg. It is accompanied by some handsome figures, and deals with *Triarthra longiseta*, *Floscularia proboscidea*, *Microcodon clavus*, *and Brachionus rubens.*

The Anatomy of the Earth-worm.—M. Ed. Claparède communicates a most extensive memoir on the anatomy of the earth-worm to Siebold and Kölliker's *Zeitschrift*, Band 19, Heft 1. This extends over more than sixty pages, and is illustrated by five large and handsomely coloured plates, in which all the structural details are dealt with. We are glad to see that our countryman, Mr. E. R. Lankester, meets with an appreciative analysis of his researches on the *Lumbricus terrestris*.

Rhythmical Contractions of Lymphatics.—Dr. A. Heller alleges that he has witnessed this phenomenon in the lymphatics of mammals, especially of guinea-pigs.—*Vide* 'Archives de Physiologie,' December.

The Development of Insects.—This is a full and good memoir, by Professor Melnikow, of Kasan. It is well illustrated, and treats of the different phases undergone in the development of the ovum.—*Vide* Troschel's *Archiv für Naturgeschichte*, Heft 2, 1869.

New Minute Bones in Fishes.—In the December number (1869) of the 'Ann. Nat. Hist.,' Professor Gulliver gives an account, with an engraving, of undescribed bones or pieces in the skull of osseous fishes. These ossicles occur in pairs, and in pits of the post-frontals, mastoids, and paroccipitals. The development and microscopic structure of these new ossicles, compared with the connected bones, might afford an interesting inquiry, and probably prove as instructive as the morphological question. It was while confirming, by dissection, the accuracy of Mr. Gulliver's discovery of the new bones connected with the post-frontals, that Mr. James Flower discovered the other two new bones; and we presume they may be all seen at the College of Surgeons. Mr. Gulliver remarks that, "a correct understanding of the bones which enter into the composition of the skull of the fish is said to be the key to the composition of the skull of all vertebrata. But now it seems that all these bones or pieces in fishes have not yet been recognized, much less understood; while it is obvious that, until every part of the skull has been estimated at its true value separately, as well as with its connections in the species and homologies as regards other vertebrata, no complete view can be given of this important part of osteology."

Terminations of the Nerves in the Skin.—The recent researches of M. Podcopaew on the relation of the nerves to the Malpighian layers of the skin of the rabbit lead him to believe that he can trace the nerves, in specimens acted on with gold chloride into the Malpighian layer. It is to be questioned, however, whether the structure described beneath are not purely artificial. Branched lines come into view lying between the cells of the rete, continuous with easily demonstrable nets lying beneath the rete. From the former, very delicate darkly-tinted lines may be traced, which run up between the epithelial cells, and near the surface again form fine plexuses. The subepithelial plexus of nerves consists of non-medullated fibres, on the sides of which a few nuclei are attached.

The Blood-corpuscles as diagnostic of Species.—We see from a report of a lecture by Professor Gulliver* given to the East Kent

* 'Scientific Opinion,' December.

Natural History Society that the Professor still holds to his views on the above point. About a quarter of a century has elapsed since the lecturer proved that certain mammalia or birds in the Zoological Gardens could be distinguished merely by their blood-corpuscles from every other animal in that great menagerie; and that the form and size of the corpuscles is so characteristic that, whenever an aberration in these points occurs in the red corpuscles of any species, that will most likely be an aberrant species—Basaris, Cercoleptes, Hyrax, &c., *e. g.* Again, the very marked uniformity in the red corpuscles of birds corresponds to the comparative uniformity of the general organization in the class; and the greatest differences of the red corpuscles will be found in those species of a class or order having the greatest divergences in its general structure or organization. Nay, even in mammalia that appear to be closely allied, should any marked difference exist between the red corpuscles of any two or more species, it may be at once inferred that the one in which the divergence is found will prove to be an aberrant member in its general organization. The lecturer had long since given proofs of these views; and, very recently, had discovered another most interesting one, the details of which he has not yet published, but would soon do so in a distinct memoir. Briefly, the point is as follows:—An eminent anatomist, well acquainted with the lecturer's discovery of the singular minuteness of the red corpuscles of the blood of the Musk Deer (*Tragulus*), of which the different species have long been known in this country under the generic name of "Moschus," sent him some dried blood of another or true Musk Deer; which, after careful examination and measurements, Professor Gulliver declared could not belong to any species closely allied to those three which he had formerly examined, since the red corpuscles of this *Moschus moschiferus* were so much larger that their average diameter was no less than $\frac{1}{7069}$th of an English inch. And then he was assured, by the eminent professor and conservator of the museum at the College of Surgeons, that this true Musk Deer (*Moschus*) would really prove to belong to a different genus from that which included the old Musk Deer (*Tragulus*), and, in short, that the difference between the structure of the two species or genera was no less than the lecturer's examination merely of the red corpuscles had led him to believe.

The Structure of the Muscles in various Animals.—This has been recently submitted to investigation by Herr Dr. Hensen, who has published his results in the last number of the 'Arbeiten,' of the Physiological Institute of Keil, and of which the 'Lancet' (Dec. 4) gives an excellent summary. Dr. Hensen has made careful microscopic investigations of the muscles in various mammals, crustacea, and insects, and advances the following theory of the structure of striated muscle. Leaving out of consideration the sarcolemma, the nuclei, and the investing mass of protoplasm around the nuclei, muscle, he believes, is composed of four distinct substances, so intimately united or blended with one another as to constitute a soft solid mass. Three of these are arranged in a laminated manner, and form columelli; the fourth separates the columelli from one another. The columelli do not, in Dr. Hensen's view, appear to be precisely identified with fibrillæ, since he considers the fibrils of ordinary microscopical description as being capable of further cleavage in a longitudinal direction to an indefinite extent. He admits the correctness of the usual statement, that when a fibril is examined it presents dark striæ and an intervening substance; but he maintains that this last is traversed by a fine line, which he thinks is a discovery, though it was long ago observed and described in this country by Carpenter and others; and he also divides the dark striæ themselves into two halves, between which is interposed a dull, finely granular disc, which he calls the median disc. Thus the fibril would be composed of the following laminæ: first, one-half of a dark stria; secondly, the median disc; thirdly, the other half of the dark stria; fourthly, the intermediate substance, which is itself divided by a dark line.

The Auditory Organs of Fresh-water Mollusks.—Some interesting points in the microscopy of these structures are to be found in a paper by Professor Gulliver in the 'Journal of Anatomy,' vol. iv. The paper has been forwarded to us by the author.

The Gregarina gigantea of the Lobster.—In the number of the 'Bulletins of the Royal Academy of Belgium,' just issued (No. 11, 1869), M. Edouard Van Beneden gives a long account, with a plate, of the anatomy and development of the above *Gregarina*. M. Schwann, who reported on the paper, speaks of it in the very highest terms, and in accordance with the theory which he originated, and to which he still adheres, regards the animal as a monster cell. The species is a new one and has been given the above name by the author, who agrees with Kölliker and Schwann in looking on it as a unicellular animal. The author does not add many histological facts to those already pointed out by Mr. Ray Lankester and Mr. Leidy, but he gives a very interesting description of the movements of the animal. He found twenty-five of these parasites in the intestines of a single lobster. He points out that the relation of the amœbiform bodies to the encysted psorosperms is yet undetermined.

NOTES AND MEMORANDA.

Improved Spring Clip.—Mr. W. P. Marshall sends us the following account of a clip which he has devised. We have seen a specimen, and consider it useful. In this form of wire clip for holding down the cover glass during the preparation of an object, my intention has been to admit of readily examining an object in the microscope with the clip on, without risk of the clip getting shifted and displacing the cover glass. The clip is put on at one end of the slide, and confined to a straight line along the middle of the slide; the lower half that clips on the slide reaches half-way to centre, and the wire is then bent back again to the end; and the upper half of the clip is carried up in a bow, the end being curved down to press upon the centre of the slide. The lower half of the clip holds firmly upon the glass slide, being a *strong* short spring; and the upper half being a *weak* long spring, gives the required delicate pressure on the cover glass independently of the other spring. The point of the clip is turned down sufficiently to prevent any risk of touching the wet varnish round the cover glass, and applies the pressure only on the centre; and the clip is curved away sideways so as to allow of an objective of short focus being used in examining the object whilst the clip is on. The lower end of the clip ends in a flat ring, that is kept clear of the field; and the bottom edge of the slide being left free, the object can be safely placed on the stage of the microscope for examination during mounting, without any risk of the clip getting accidentally displaced. In putting on the clip, it is held by the upper bow with the finger and thumb, and first slipped on to the slide, and then adjusted to its position, holding up the point clear of the cover glass until in its right place. The same clip, with the point not turned down, is more convenient often for examining flowers, &c., in the microscope, than using the ordinary stage forceps; the petals or other parts of a flower being held down *firmly* and *flat* upon the glass slide during examination. These clips can be readily made by any one, and adjusted as required to different degrees of pressure by slightly bending; they are also supplied by Messrs. Field, of Birmingham, neatly made of light steel wire.

The Son of a late Fellow.—An effort is being made by some of the Fellows of the Royal Microscopical Society and other charitable persons to obtain votes and other support in behalf of the child of a late Fellow of the Society (Mr. Hall). The case is one deserving the sympathy of those who belong to the Society; and, as charity begins at home, we trust that those who have any power in the matter will exert it for the benefit of the little fellow, who is a candidate at the present election (January) of the London Orphan Asylum, Clapton. The case is strongly recommended by Stanley Vickers, Esq., M.P., Victoria Street; D. De Berdt Hovell, Esq., F.R.C.S.E., Five Houses, Clapton; *P. Gowlland, Esq., F.R.C.S., 34, Finsbury Square; H. N. Nissen, Esq., 43, Mark Lane, London; H. Hughes, Esq., Southcote Lodge, Reading; C. A. Aylmer, Esq., Peel River Company, London; *C. Wellborne, Esq., Duke Street, Southwark; F. Nash, Esq., Lower Norwood; *H. P. Wellborne, Esq. Adelaide Villa, Brunswick Road, Camberwell; *Thos. Kesterton, Esq., Sutton, Surrey; *A. H. Billing, Esq., 9, Carlton Villas, Angell Park, s.w. Proxies will be thankfully received by those marked*.

New Microscopical Societies. — Three new Societies have been founded in the Provinces, two of which are exclusively microscopical and one partly so. The two first are those of Leamington and Tunbridge Wells. The third is the "Winchester and Hampshire Scientific and Literary Society." The officers of the Tunbridge Wells Society, the prospectus of which we have seen, are:—President, Dr. Deakin; Treasurer, John Stone Wigg, Esq.; Secretary, Rev. Benjamin Whitelock.

Stricker's Handbook of Histology.—The first part of this work, which is to be issued in English to the members of the Sydenham Society, has been translated by Mr. Henry Power, F.R.C.S. It is not, however, yet in the press; but, as the MS. is complete, we may hope for the publication of the volume early in the spring.

Mounting Brain Sections.—Dr. Bastian informs us that the reason why Stieda's process of mounting sections was not more fully given in his (Dr. Bastian's) paper before the Royal Microscopical Society, was that it had before been dealt with at length in his paper in the 'Journal of Anatomy and Physiology.'

How to choose a Microscope is the title of a paper by Dr. J. Baker Edwards, in the last number of the 'Canadian Naturalist.'

An Italian Prize for Chemical Microscopists.—A prize of nearly nine hundred lire will be given next month by the Royal Institution of Lombardy for the best Essay on the Chemico-microscopical Examination of Milk, to demonstrate the nature of the substance which sets fermentation going, *i. e.* whether an organized or chemical substance.

The Journal of the Quekett Club.—We believe we are correct in stating that the Quekett Club will not in future issue a Journal, but will be content with an annual volume of Proceedings. Papers, read before the meetings, may, we believe, appear in our pages.

Photography and the Microscope.—A contemporary states that Dr. Moitessier's work, entitled 'Photography as an Aid to Microscopical Research,' has been translated into German by Dr. Benecke, of Königsberg, who has re-edited aud enlarged its contents.

Tolles' New Method of Illuminating Opaque Objects under High Powers.—The 'Boston Journal of Chemistry,' quoted by the American 'Dental Cosmos' of December, gives a long account of this method. A description is given of Professor Smith's plan and others, but the writer thinks that none of these methods have come into general use; the great difficulty with them has been that most of the light is reflected to the eye of the observer by the lenses, before reaching the object, thus producing a glare, which renders the object indistinct. By very careful and tedious manipulation, the writer has sometimes obtained a pretty good effect with Professor Smith's illuminator, but more often, after working a long time, has failed. "Soon after Professor Smith's instrument was described, Mr. Tolles, then in Canastota, produced an instrument varying materially from the others. In this a prism is inserted in the side of the objective, between the front and middle combinations, of such a shape that a beam of light, received at the side of the objective, is thrown by a totally reflecting surface through one side of the front lens, at such an angle that none of it is reflected, but all passes through and is condensed on the object, and from that reflected back to the eye. Only one of these instruments (now owned by a physician of Boston) was then made. Recently Mr. Tolles has made two more of them, and their performance is such as to promise that little, if any, improvement can be expected in this direction. Opaque objects are seen with 4-10ths and 1-4th inch objectives (from 200 to 500 diameters), brilliantly illuminated on a black background. The appearance of diatoms is similar to that obtained with the parabola, but the details of surface are shown with a distinctness never before seen. Of how much utility this is to prove, and what discoveries are to be made in the works of nature with it, are among the problems that the microscopists are called on to solve.

Dr. Woodward's Article in No. XII. of this Journal. An Explanation. — Some apology is due to Dr. Woodward for the omission of the diagram from his paper, as published in our last. The omission was caused by inadvertence or forgetfulness on the part of the Secretary, Mr. Jabez Hogg. On noticing that the printer had left space for a diagram we sent to Mr. Hogg—who had, of course (as Col. Woodward's representative), compared the manuscript and proof before sending it to us—to ask him whether there was a sketch of a diagram for Dr. Woodward's paper. To this Mr. Hogg replied, that he knew of nothing of the kind! The only course open to us, therefore, was that expressed in our foot-note to Dr. Woodward's paper, and it remains for Mr. Hogg to explain how he compared Dr. Woodward's proof with the MS., and yet failed to see the diagram in the latter.

Professor Huxley's Classification of Animals. — A very severe and long critique on this book appears in the 'American Naturalist' for December.

A New Treatise on Microscopic Objects. — Mr. Van Voorst is about to issue a very comprehensive treatise on Microscopic Objects. The Author is Mr. J. H. Martin, Secretary to the Maidstone and Mid-Kent Natural History Society. The first part was to have been issued on the 1st of this month. Each part will contain eight plates and eight pages of text. The whole number of figures will be 200, and we cannot help thinking that Mr. Van Voorst will have to exert more than his ordinary skill as a scientific publisher, if he contrives to include the whole range of histology in these. The figures will be faithful drawings of the structures as they appear when as nearly as possible filling the ordinary field of the microscope. It is proposed to commence with the primary forms of Vegetable life, and to proceed onwards through the tissues to the woody structures of the Exogens and Endogens, next descending to the Acrogens, and so passing to the extreme limits of vegetable life, as the Desmideæ, &c.; hence to the lower forms of Animal life, the Infusoria, and on through the Radiata to the Insects, which will be drawn and described in their various orders, and the minute organs figured separately. In the concluding Plates will be represented interesting and characteristic geological structures, with some of the more curious forms and groupings of crystals. The description of the objects will be brief, and, as far as possible, void of technicalities; and no attempt will be made to enter into details relating to their physiological action.

Blankley's revolving Mica-Selenite Stage. — This stage, which was recently exhibited to the Society by Mr. Slack, consists of two brass plates, $3\frac{1}{2}$ in. long by $1\frac{1}{2}$ in. wide, between which is placed a brass disk with an aperture in the centre, in which is placed a thin film of Mica. By placing the Selenite under this stage and the object upon it, and revolving the milled edge of the rotating disc, a very great variety of colour will be obtained. The Mica appears to have the power of developing or drawing out the colour in the Selenite. It will be observed that by using this piece of apparatus the polarizer is not touched, but by altering the angles of the polarizing prisms the variety of tints and colours will be still further increased. The stage can be used with an ordinary selenite or with any sliding and compound selenite stages. It is made by Mr. Swift, of Kingsland Road, London.

Vegetable Hairs.—These structures offer our readers an excellent field for easy and interesting work, and as an introduction to the subject we commend to their notice an illustrative and good paper, "Vegetable Hairs," in 'Science Gossip' for December.

Brass Cells. — Mr. T. W. Wonfor, the well-known secretary of the Brighton and Sussex Natural History Society, considers that cells made of india-rubber bands and such-like materials are useless if required to last. He recommends brass cells.* These, he says, which are cheap and easy to fix, he makes from brass rings; he used to employ different sized curtain-rings, until he became acquainted with those referred to. They are used by tailors as button moulds, and can be purchased in three sizes, at a woollen-draper's or tailor's trimming warehouse, at from 10*d.* to 1*s.* 4*d.* per gross; and therefore as regards cheapness can compete with the endless bands. As to the mode of fixing: this is done by marine glue, or one of the many cements used for fixing glass and brass, or repairing glass or china. He prefers the marine glue, because when properly manipulated it never fails, and the slide will sooner break than the cell come off. His *modus operandi* is as follows: first, centre a batch of slides, and cut some marine glue into pieces the size of a pin's head; then, with wooden forceps, seize one end of the slide, drop a ring on centrally, place three or four pieces of glue at intervals outside, and touch the brass ring; hold the slide over a spirit-lamp, until the glue by capillary attraction runs under (care must be taken not to bake too much); then drop the slide on wood to cool, when the superfluous glue may be removed with a knife. To fix the glass cover, paint the ring with gold-size, and when tacky, drop on the cover; when dry, give it a coat of gold-size, and finish it off with asphalte or coachmaker's varnish. If required for fluid, he either paints the inside with gold-size or with electroplate before fixing. If a deeper cell is required, he cements two rings together.

* 'Science Gossip.'

CORRESPONDENCE.

Collins's Erecting Dissecting Microscope.

To the Editor of the 'Monthly Microscopical Journal.'

New York College of Veterinary Surgeons,
205, Lexington Avenue, *Nov.* 22, 1869.

Dear Sir,—In the October number of the 'Monthly Microscopical Journal' you mention, under the head of "Notes and Memoranda," what you call a new dissecting microscope.

Allow me to say that for the last five years I have been using an instrument invented by Dr. John Busteed, of this city, and made by Mr. Grunow, one of our best opticians, which has exactly the same advantages and is similarly made in every respect, having a revolving stage and compound body with prism erector.

If this instrument possesses any advantages over others, the originality of the idea is due to Dr. John Busteed.

Respectfully yours,
A. Swintard,* M.D., V.S.

PROCEEDINGS OF SOCIETIES.†

Royal Microscopical Society.

King's College, *December* 8, 1869.

The Rev. J. B. Reade, M.A., F.R.S., President, in the chair.

The minutes of the last meeting were read and confirmed.

The President said that the vote of thanks to Dr. Pigott, recorded in the minutes, had been well earned, for the paper which he had communicated to the Society was an exceedingly valuable one, notwithstanding the doubts which had been expressed as to the correctness of the conclusions it contained. He (the President) had, in company with Dr. Millar, had had two or three interviews with Dr. Pigott, and had witnessed the exhibition of the true *Podura* test-scale, *viz.* that of *Lepidocyrtus curvicollis;* and he felt bound to say that Dr. Pigott had brought out appearances which are very naturally described as rows of beads, whatever their real character might ultimately be proved to be. It was very clear to him, that Dr. Pigott's peculiar optical arrangements led to the correction of

* We cannot vouch for the correctness of our correspondent's name, his signature is so fearfully unintelligible.—Ed. M. M. J.

† Secretaries of Societies will greatly oblige us by writing their reports legibly —especially by printing the technical terms thus: H y d r a—and by "underlining" words, such as specific names, which must be printed in italics. They will thus ensure accuracy and enhance the value of their proceedings.—Ed. M. M. J.

the small residuary aberrations which exist in the best object-glasses by an equal and opposite amount of aberrations, as spoken of in the paper; and in this respect he (the President) thought that the leading opticians would do well to avail themselves of Dr. Pigott's suggestions. In addition to this he would mention that the stage itself is one of peculiar interest, having been made by Dr. Pigott himself, to whose practical skill as a worker on the lathe many could testify. The peculiarity of the stage consisted in the secondary stage being brought up to the primary one, the whole being about a $\frac{1}{4}$ of an inch in thickness, and even under a $\frac{1}{16}$ the circular motion is so perfectly concentric that the minutest object remains, as it were, fixed on the field of view. There are two screws which regulate the condenser, and also two which regulate the rectangular motion of the stage, that motion being produced by the moving of one circle within another. The abstruse mathematical calculations employed in the correction of the residuary aberration are to be communicated to the Royal Society, and a further communication would be made also to the Royal Microscopical Society. These remarks he (the President) had made in justice to Dr. Pigott. The President added, that Dr. Pigott was precluded from attending the meetings of the Society by the state of his health, but that he was willing to show the *Podura* markings at his own residence to any of the Fellows who would favour him with a visit.*

The list of donations was then read.

Mr. Slack announced that the Society had received two presents from Dr. Millar: the one, consisting of an original form of the parabola, devised by Mr. Wenham; and the other, of the original "finder," devised by the Committee of the Society. Dr. Millar stated that the finder had been obtained from the collection of Mr. Jackson.

A vote of thanks was then passed to Dr. Millar and the other donors whose names had been mentioned.

Mr. Slack briefly explained the nature of a communication from Mr. C. Staniland Wake "On Organisms in Mineral Infusions," which will appear in the 'Transactions.'

Mr. Wake made infusions of coal and other mineral substances, and then examined the organisms which grew from or upon particles they contained. Mr. Wake spoke of these organisms as if they had retained their vitality from the formation of the mineral; and though this is rather a startling statement, he is not alone in this view, for a similar opinion had been enunciated before the French Academy by M. Béchamp, who had discovered certain bodies in chalk, which he found were capable of acting as ferments, which he named Microzymas. He presumed these bodies to have preserved their vitality in the fossil state.

* Mr. Hogg desires us to insert the following note:—"I regret to find in the report of my observations on Dr. Pigott's paper (Dec. 1, p. 333) that the last sentence assumes the form of a personal comment. Press of engagements unfortunately prevented me from making an intended and necessary addition and correction, and I now gladly take the opportunity of adding to the above observations of the President my own present opinion of the value of Dr. Pigott's paper."—JABEZ HOGG.

Dr. Murie then, at the request of the President, gave a short summary of a paper communicated by Dr. Macintosh "On the Stylet Region of the Ommontoplean Proboscis."

These papers were then taken as read, and a vote of thanks passed to the authors.

The President then called on Professor T. Rymer Jones, F.R.S., to read a paper "On Deep-sea Dredgings, from the Vicinity of China and Japan."

Mr. Brooke said that he would make only one remark in confirmation of the statement of Professor Jones in reference to the abundance of life which existed at the bottom of the sea. At the late meeting of the Royal Society Dr. Carpenter had mentioned the fact that in his recent expedition a cable, composed of rope, the end of which was so arranged as to form a loose tangle, was let down to a depth of 2000 fathoms, and was brought up covered with certain kinds of Echinus, in such numbers that, after furnishing specimens sufficient to supply all the Museums in Europe, they were obliged to stamp them out in order to get rid of them.

Mr. Slack said it was evident that the physical problems of deep-sea life had not been understood. If pressure on living creatures at the bottom of the sea is equal in all directions, from their being permeated with fluid pressing from within as well as from without, there was no reason why they should not bear it as easily as we bear the pressure of the atmosphere. But the chemical conditions of the depths of the sea must differ considerably from those which existed on the earth's surface. It might be supposed that the ultimate molecules of matter would have to bear the whole pressure external to them, and adjacent molecules might be so closely compressed as to cause chemical action to vary materially from that which goes on on the surface of the earth. Composition and decomposition might be presumed to take place with much greater or much less facility according to circumstances.

Mr. Hogg was glad to find that the discoveries of Dr. Wallich had received from Professor Jones the recognition which they merited.

The President said, with reference to the chemical conditions at the bottom of the sea, which were alluded to by Mr. Slack, he had been much interested in the statement as to the large amount of carbonic acid gas existing there, as was clearly the case from the report of Professor Jones. The creatures described by him must supply an enormous quantity of this noxious gas, so as to render it a matter of surprise as to how it was possible for them to live surrounded by it. He could only suppose that the balance of vital conditions was maintained, by the effect which the violent commotions to which tho sea was subject was produced, in causing the gas to rise.

A vote of thanks was then passed to Professor Jones.

The meeting was then adjourned to January 12th, when papers will be read by W. S. Kent, F.Z.S., F.R.M.S., "On the Calcareous Spicula of the Goronaceæ: their modification of form, and the importance of their characters as a basis for generic and specific diagnosis." By John Browning, F.R.A.S., &c., "On a new mode of Measuring

Spectra Bands." By Alfred Sanders, M.R.C.S., F.R.M.S., "On an Undescribed Stage of Development of *Tetrarhynchus Corallatus*."

Donations to the Library and Cabinet from November 10th to December 8th, 1869:—

	From
Land and Water. Weekly	*Editor.*
Scientific Opinion. Weekly	*Editor.*
Society of Arts Journal. Weekly	*Society.*
Nature. Weekly	*Editor.*
Royal Society's Catalogue of Scientific Papers. Vol. III. ..	*Society.*
Proceedings of the Academy of Natural Sciences of Philadelphia. 1868.	*Academy.*
The Chemical News. 3 Parts.	*W. T. Suffolk, Esq.*
A Reade's Prism	*The President.*
A Brewster's Hemispherical Prism	*The President.*
The "Finder," recommended by a Committee of this Society, described in vol. v., p. 95, of the 'Quarterly Journal of Microscopical Science.' 1868.	*Dr. Millar.*
Mr. Wenham's original Silvered Parabola, made by Smith and Beck in 1850	*Dr. Millar.*

The following gentlemen were elected Fellows of the Society:—

Ezra Thomas Downes, Esq.
F. G. Mountford, Esq.
William Rutherford, M.D., Professor of Physiology in King's College, London.
F. H. Ward, Esq., M.R.C.S.

Walter W. Reeves,
Assist.-Secretary, &c.

Quekett Microscopical Club.*

At the ordinary meeting held at University College, October 22, P. Le Neve Foster, Esq., M.A., President, in the chair,—five new members were elected; four gentlemen were proposed for membership; several presents to the library were announced, and fifty-three slides were presented to the cabinet, for which the thanks of the club were returned. Mr. B. T. Lowne, M.R.C.S., read a paper "On the Aid derivable from the Microscope in the Classification of Animals," observing in his introductory remarks that although the microscope had been of great advantage to the naturalist in cases where the animals were too small for unaided vision, and had been of still greater service in determining observations upon embryology, showing to us the distinctive modes of segmentation in vertebrate and invertebrate animals, he should not touch upon these points, but should rather treat of the ultimate histological structure of animals as an aid to classification. After briefly noticing the Amœba as the simplest form of animal, consisting merely of a mass of sarcode without histological structure, the author observed that rising in the scale we next found the integument hardened and becoming the first form of a cell. Of this the Gregarina was taken as an example, its appearance was described and illustrated, and its resemblance to an

* Report supplied by Mr. R. T. Lewis.

ovum after segmentation was pointed out. The Gregarina might be considered as consisting of a single cell, from which, rising still in the scale, other animals were found to consist of cell upon cell, a fact which gave rise to the celebrated cell theory of Schwann. The formation of muscular tissue by the fibrillation of the plasma was next referred to, and the difference in the appearance of striated and non-striated muscular fibre pointed out, it being explained that in the human body the involuntary muscles consisted of non-striated, and the voluntary muscles of striated fibre. The author then proceeded to show that throughout the mollusca, both in the voluntary and involuntary muscle non-striated tissue alone was to be found, whereas in insects nothing but striped tissue existed. Two most important exceptions, however, existed to these rules—the Serapis, one of the lowest of the mollusca, was said to possess striped muscular tissue, whilst the Annelida, which lead up to the type of insects, exhibit nothing but unstriped tissue. It had been stated that the muscles of insects were of far larger formation than those of the vertebrata, but this he was able to contradict, having demonstrated that although in the larval state they were larger, in the higher forms of insects they were either smaller or of the same size; there was in fact no difference between the striped muscular tissue in the highest and the lowest forms, except in point of quantity. Dwelling at some length upon these facts, the author pointed out their bearing upon the great question of the Origin of Species, and concluded by expressing his belief that the microscope would one day be the means of demonstrating whether Darwin's theory were right or wrong. The paper elicited the loud applause of a large and most attentive audience, and a well-merited tribute to its value was paid by Dr. Braithwaite; after which Mr. Hailes called attention to a small portion of skin from the door of the Pyx Chamber in Westminster Abbey, which he exhibited under the microscope, and unanimous votes of thanks were passed to Messrs. Lowne and Hailes for their communications. The usual *conversazione* concluded the proceedings.

ERRATUM.—Page 286, line 6, *for* Biology *read* Bryology.

At the ordinary meeting held at University College, November 26th, P. le Neve Foster, Esq., M.A., President, in the chair, four new members were elected, six gentlemen were proposed for membership, and a number of donations to the club were announced. Mr. A. E. Durham exhibited a new portable dissecting and mounting microscope, designed by Mr. Marshall and manufactured by Messrs. Field, which was justly described as *multum in parvo*. Mr. Durham also read a communication from Professor Tomlinson, suggesting microscopical observations on the movements of small pieces of camphor placed upon solid surfaces, and requesting information as to the results. Mr. W. Hislop read a paper upon "A New Selenite Stage," in which a plate of mica was so fitted as to be rotated above the plate of selenite, producing a variety of colours; a diagram of the contrivance was exhibited. Mr. M. C. Cooke read a translation of a paper by Count Castracane, "Upon the Italian Methods of Micrometry," and an interesting discussion followed, in which Dr. Matthews, Messrs. Lowne, Breese, Golding, and Groves took part. The Secretary read a paper "On the Albertype Process of Photographic Printing," suggesting its application to the illustration of microscopical subjects; specimens of a portrait printed by the process were distributed in the room, and a discussion upon its merits ensued. The conclusion of the ordinary business of the club was made the occasion of an interesting presentation to Mr. W. M. Bywater, who for four years had so ably filled the office of honorary secretary. Arthur E. Durham, Esq., F.L.S., late President of the club, having been called to the chair, referred in an able and highly complimentary speech to the valuable services rendered by Mr. Bywater during his period of office, and paid a well-merited tribute to the courteous and efficient manner in which his arduous duties had ever been performed. Mr. Durham then, amidst great applause, presented, in the name of the members, a handsome silver salver and tea and coffee service; the salver bearing the following inscription:—"Presented, together with a silver tea-service, to Witham Matthew Bywater, by members of the Quekett Microscopical Club, as a token of appreciation of his indefatigable exertions both as a founder of the club and as the honorary secretary during four years.—1869." Mr. Bywater, in a brief but very suitable manner, acknowledged the valuable gift, expressing his deep sense of the honour conferred upon him by those with whom he had so long been associated, and cordially thanking them for the very handsome testimonial presented to him. The proceedings terminated as usual by a *conversazione*.

Literary and Philosophical Society of Manchester.

Ordinary Meeting, October 19th, 1869. J. P. Joule, LL.D., F.R.S., &c., President, in the chair. "On a New Form of Calamitean Strobilus," by Professor W. C. Williamson, F.R.S.

The author referred to the labours of Mr. Binney and Mr. Carruthers in elucidating the structure of the ordinary type of Calamitean Strobili as affording a standard of comparison, and then proceeded to describe his specimen, which was from the cabinet of Mr. J. Butterworth, of High Crompton. It had been a strobilus approaching nearer to Aphyllostachys than to Volkmannia, only the three lowermost verticils or joints were preserved. Externally the central axis had been fluted longitudinally like the stems of Calamites. It consisted of a medullary cavity surrounded by a cylinder consisting largely of cellular and prosenchymatous tissues, but also containing, in the prominent external ridges, bundles of *reticulated* vessels. Where these vessels crossed the nodes they described a series of arches of which the concavities were directed towards the medulla, as the author had, in a previous memoir, pointed out to be the case in Calamopitus. Immediately above and below each node the ten external ridges of the axis gradually became more prominent until, at the node, they coalesced, converting the external grooves of the axis into short canals, of which the transverse section was pyriform, and forming a continuous foliar disk, chiefly of cellular tissue, in which were an outer series of twenty smaller pyriform apertures diverging obliquely in pairs from each of the ten larger ones. At the outer angle of each smaller aperture a sporangiophore ascended almost vertically into the cavity of the strobilus, being nearly parallel with the central axis. This sporangiophore supported three or four sporangia grouped around it in a horizontal verticil, the horizontal section of the entire strobilus consisting of a circle of these smaller sporangial verticils, which were so densely packed together as to disturb and mask the regularity of their arrangement. Having given off these sporangiophores with the reproductive organs which they supported, the verticillate foliar disk dipped suddenly downwards, and, describing a circular curve, as suddenly outwards and upwards, where it terminated in a verticil of numerous ovato-lanceolate bracts, which enclosed the exterior of the segment to which they belonged and protected the contained sporangia. The author pointed out where the strobilus differed from those described by Binney and Carruthers. In the former each node gave off a horizontal verticil of coalesced bracts, from the centre of which a series of sporangiophores ascended as vertical divergent branches, whilst in the latter there was an alternating arrangement, one node giving off the disk of coalesced bracts, and the next a verticil of sporangiophores springing at right angles *from the central axis*, and having their respective sporangiophores clustered round them in perpendicular verticils. In the author's example the sporangiophores were densely filled with spores, each consisting of an outer cell-wall, an inner cell-membrane or primordial utricle, and cell contents which were often aggregated into a distinctly defined mass in the centre of the cell. There were no traces of elaters connected with the spores.

The author pointed out that in its general aspect and in the type of its structure the strobilus was unmistakably Calamitean—the peculiarity in the position of its sporangiophores being merely generic. Its Calamitean character was further established by the peculiar arched arrangement of the vascular bundles where they cross the nodes—an arrangement which the author has never seen except in Calamites. All the detailed features of the strobilus distinguish it from those described by Binney and Carruthers, and especially the fact that, whilst in all the latter the vascular structures are scalariform as in the stems to which they are supposed to belong, in this example the vessels are reticulated. But the only Calamitean example hitherto discovered containing such vessels is that described by the author under the name of Calamopitus, to which, or to some near ally of it, he believes the strobilus to have belonged. If this be a correct conclusion, the plant furnishes an instance derived from the carboniferous vegetation of a highly-organized axis, exogenous in its growth and furnished with medullary rays, but which nevertheless sustained a cryptogamic strobilus. Such a combination, however, is but a primæval illustration of a combination still existing amongst the living Marsileaceæ, with which Calamites present some affinities. The specimen described was found by Mr. Butterworth in one of the lower beds of the Lancashire coal-measures.

Microscopical and Natural History Section.

October 11th, 1869. John Watson, Esq., President of the Section, in the chair.

The President delivered a long and interesting address, of which, however, the following is the only passage relating to microscopy:—

"Some of our botanical members occasionally meet together for excursions in pursuit of their favourite study, and it might be of advantage if the microscopical members would do the same. There are many districts which would yield reward in working, and I may mention that I have been very fortunate during the past summer in obtaining a large number of infusoria, many of them scarce and some new to me: these were found in the succession of ponds lying in the fields between Castle Mill and Mobberly, nearly every pool possessing its own genera and species, differing from the others. The finest kinds were in the ponds containing water-lilies, and particularly in two where *Utricularia vulgaris* was abundant. On the stems of this latter plant I found that finest of all the infusoria, *Stephanoceros Eichhornii*, in great beauty—a species I had never previously met with in this district; there were also *Floscularia ornata* and *cornuta*, and in addition to abundance of the more common kinds I obtained *Megalotrocha albo-flavicans*, *Scaridium longicaudum*, *Noteus quadricornis*, *Brachionus polyacanthus*, *Limnias ceratophylli*, &c., whilst among the decayed sedge-leaves there were abundance of *Oscillatoriæ*."

Dr. Henry Simpson exhibited specimens of *Statice spathulata*, gathered by himself this autumn on Hilbree Island, Cheshire.

Mr. Tait sent a portion of the beach from near Alexandria, Egypt, consisting almost entirely of shells. He stated that for miles along the coast the shore was of a similar character.

Mr. Joseph Sidebotham read a long paper on "Varieties in Lepidoptera."

November 8th, 1869. Joseph Baxendell, F.R.A.S., Vice-President of the Section, in the chair.—Mr. W. J. Rideout presented the Section with one of the "Diotamaceen Typenplatte," prepared by J. D. Möller, of Holstein, and containing 408 separate types of Diatoms, beautifully arranged within an area of an eighth of an inch. The other papers were of no microscopical interest.

Birmingham Natural History and Microscopical Society.

November 9.—The President (Mr. W. P. Marshall) read a paper, supplementary to a former one, "On the Transformations of the Gnat." He traced the several stages of the development of this insect from the egg, through the larva and pupa states, to the perfect animal, and the mode in which these transformations are effected, dwelling especially upon the interesting changes which take place in the manner of respiration, and the special arrangements by which the great alterations in the requirements of the animal in its different states are provided for. He then proceeded to describe in detail certain recent observations he has made upon this subject, which appear to give a clue to a distinct connection between the breathing apparatus in the three different stages of development, which makes it in essential structure identical in all of these, differing only in respect of the external organs. The paper was illustrated by a series of beautiful drawings, and by numerous microscopic preparations, showing the successive stages of development from the egg to the imago.

Owing to the several meetings of the summer session, a great variety of objects have been exhibited in all branches of Natural History. Our space permits us only to notice a few of the principal microscopic ones. These include, among others, the following:—

Mr. T. Bolton, collection of *Rotifera*, including *Melicerta ringens*, *Tubicolaria ringens*, *Limnias ceratophylli*, *Monocerca rattus*, *Synchæta pectinata*, *Euchlanis triquetra*, *Rotifer inflatus*, *Actinurus neptunius*, *Philodina macrostyla*, *Chœtonotus larus*, and others.

Mr. W. R. Hughes, *Bugula avicularis*, *B. plumosa*, *Bowerbankia imbricata*, and other *Marine polyzoa*, living;—Pedicillariæ of *Echinus Sphæra.*

Mr. W. Madely, *Vorticella nebulifera*, *Epistylis grandis*, *Carchesium polypinum*, *Trichodina pediculi*, *Vaginicola valvata*, *Euplotes patella*, and other *Rotifera*;—Statoblasts of fresh-water *Polyzoa*, showing adherence of the valves to the young *polyzoon*, until germination had been several times repeated (mounted).

Mr. W. P. Marshall, *Caprella linearis*, *Lucernaria campanulata*, *Phoxichilidium coccineum.* Larva of *Ephemeræ* and slides, illustrative of the development of the common gnat, from the egg to the imago, all mounted in glycerine jelly.

Mr. C. T. Parsons, *Æcidium epilobii*, *Larva* and *pupa* of *Corethra plumicornis*, very fine objects for the polariscope and dark-ground illumination.

Mr. C. Pumphrey, Pedicillariæ and Ambulacral discs of *Echini.* Living specimens of several species of *Flustra* and *Alcyonidium.*

Mr. J. Shoebotham, the Entomostracon, *Diaptomus castor*, male and female, showing the spermatic sac, &c.

Mr. E. Simpson, *Hydra viridis*; *Stentor Mülleri* and other rotifers.

Mr. G. S. Tye, Statoblasts of *Plumatella repens* and *Cristatella mucedo*, mounted; *Plumatella repens*, mounted with tentacles expanded.

Mr. A. W. Wills, *Batrachosperonum confusum*, *B. stagnale*; *Chætophora endiviœfolia*; *Raphidia angulosa*, &c.; Pedicillariæ of *Uraster rubens* and *Echinus milearis.* *Stephanoceros eichornii* — *Cristatella mucedo* and *Plumatella repens*, living — Marine polyzoa, mounted, including *Anguinaria spatulata*, *Bugula avicularia*, *Cellularia reptans*, *Flustra foliacea*, *F. membranacea*, *F. papyracea*, *Membranipora pilosa*, *Scruparia chelata*, *Valperia postulata*, *Salicornaria farciminoides*, and others.

Reading Microscopical Society.*

October 19th, 1869.—Captain Lang, President, in the chair.

This being the first meeting of the session, the President made a few remarks upon the desirability of keeping up the interest of the

* Report furnished by Mr. B. J. Austin.

meetings by a regular succession of papers; and in response, several members undertook to provide for the coming monthly meetings.

He then read a paper (prepared by Mr. Tatem) "On Collecting and Mounting Entomostraca;" in which the late Mr. Clayton's method of collecting, cleaning, and mounting (as well as the medium), was fully described. [This appeared in our November number. Ed. M. M. J.]

Mr. Tatem exhibited drawings of *Clathrulina elegans* (Cienkowski), first obtained in 1864, and repeatedly since, from a ditch near the Cattle-market, Reading. In all instances these organisms were perfectly colourless, the reticulation more polygonal, and the pseudopodia shorter and weaker than in the figure recently given in the 'Quarterly Journal of Microscopical Science.' Mr. Tatem considered the brown tinge of Mr. Archer's specimen due to bog-water, from which, possibly, it may have been procured; and further remarked that if the definition of *Podophrya* as "a stalked Actinophryan" is to be maintained, he could see no good reason for its removal from that genus.

He also exhibited *Notommata parasita* in *Volvox globator*, and a series of mounts of ovipositors of saw-flies.

Captain Lang exhibited the gizzard of *Elater nigra;* stomach, pylorus, rectal papillæ, ovary, &c., of blow-fly; head, œsophagus, and gizzard of *Corethra plumicornis; Arcella vulgaris*, mounted in a mixture of Rimington's jelly and glycerine; tongue of *Trochus*, mounted in the same medium; and *Bacillaria paradoxa*, dry.

Mr. Amner exhibited embryo mussels.

November 16th.—At this the Annual Meeting of the Society, after the report and balance-sheet had been considered, and the usual business transacted, Captain Lang read a paper "On Diatomaceæ," having for its object the discussion of different plans of arrangement proposed by the most noted Diatomists. These he considered to be two: Professor William Smith's, based upon the mode of growth, leading to a division into three principal families, the free, the adherent, and the frondose, subdivided into tribes, sub-tribes, and genera; according to the existence or non-existence of gelatinous envelope, &c.; and the system adopted by Kützing, Grunow, Ralfs, Heiberg, and others, based upon the form and structure of the individual frustules. He also entered into the merits of Reade's prism and of immersion lenses, as aids in the study of diatoms, and incidentally referred to Dr. Macdonald's views of diatom development, and to Mr. Stoddart's theory of the two-layered structure of the diatom-valve.

The paper was illustrated by a series of slides, showing types of genera as arranged by Professor William Smith, and by Möller's No. 1 type slide.

Brighton and Sussex Natural History Society.*

November 11th.—The President, Mr. T. H. Hennah, in the chair. A rare grass, *Gastridium Lendigerum*, obtained October, 1869, in the Weald of Sussex, by Mr. Davies, was presented by that gentleman.

A paper "On Mosses" was read by Mr. Smith, in which the

* Report supplied by Mr. Wonfor.

development, growth, mode of reproduction, and the several parts of mosses were described and illustrated by enlarged drawings and microscopic preparations, the most notable among the latter being *Ephemerum serratum*, showing vaginicola and pro-thallus; *Orthotrichum Lyellii*, exhibiting gemmæ on leaves; and *Leucoboyum vulgare*, showing section of leaf. It was also pointed out that to the microscopist the mosses opened out fields of research and questions to be settled unsurpassed by any other branch of nâtural history.

Prior to reading the paper Mr. Smith handed in a complete Bryological Flora of the county of Sussex, comprising 298 species and sub-species, a brief account of the soils in which the rarer species grow, together with an enumeration of those which at present, as regards Britain, have been found only in Sussex. This list will be published in the Society's next annual report.

Dec. 9th. The President, Mr. T. H. Hennah, in the chair.—A paper was read by Mr. C. P. Smith "On the Gemmæ of Mosses." In flowering plants the seed is an embryo plant provided with a stem, root, and leaves, which only require developing to produce a perfect plant. In mosses, the spore is but a simple cell, without any germ or embryo of the future plant, which gives rise to an intermediate state, so that mosses are plants of two, or rather alternating, generations; in the first the spore gives rise to the pro-thallus, and the first generation is completed, when the different sexual organs are formed, by the co-operation of which the primary mother-cell of the second generation is produced; this afterwards becomes the fruit-rudiment and eventually the capsule, thus completing the second generation. In addition to this mode of generation, there is another by means of gemmæ or sprouts. In all known British, none of the side-fruiting (Pleurocarpi) as yet are known to show gemmæ, which are defined as loose granular bodies, capable of becoming plants. The situation in different mosses varies; thus in *Tortula papillus*, which grows on trees in Sussex and elsewhere, and has a thick spongy nerve, the gemmæ are found on the upper part of the inside of the leaf; the fruit of this moss is unknown except in Australia; in *Didymodon gemmasceus*, having the nerve excurrent, the tip is crowded with gemmæ; *Tetraphis pellucida* has them in pedicellate clusters at the ends of separate stems; in *Webera annotina* they assume the form of beds in the axils of barren branches; *Bryum Atropurpureum* has tubercles or bulbs in the axils of leaves. On the leaves of *Orthotriche Lyellii* grow little strings of cells, which being thought to be of confervoid nature, were named *Conferva castanea*. It has since been demonstrated that these confervæ gradually develop into young plants of mosses. *Oncophorus glaucus* has a great number of cells, forming a dense mass at the tip of the leaf; these, in the damp season, give rise to numbers of young plants; hence this plant is common in countries where it does not produce a true fruit. The subject of the growth of gemmæ has not been thoroughly investigated; he purposed investigating the phenomena, when he hoped to lay before the Society some new facts. After a discussion, a number of very interesting specimens prepared by Mr. Smith was exhibited under the microscope by the following gentlemen; the most striking were by—

Mr. Hennah, *Mnium cuspidatum*, hermaphrodite flowers, showing archegonia, anthridea, and paraphytes; *Mnium Hornum* and *Polytrichum* communed showing ♂ flowers; *Neckera oligocarpa*, ♀ flowers, consisting of archegonia and paraphytes.

Mr. Smith, *Cinclidium stygium*, with cupiliform peristome; *Ceratodon purpureus*, peristome with divided teeth; section of leaf of *Polytrichum formosum*, covered with papillæ; *Ephemerum servatum*, with pro-thallus and young buds.

Mr. Sewell, *Pottia cavifolia*, section of leaf exhibiting layers; *Orthotrichum Lyellii*, with confervoid gemmæ on the leaves; this is the *Conferva castanea* of the early botanists.

Mr. Wonfor, *Aulacomnion androgyum*, showing gemmæ in pseudopodia; *Ullota phyllantha*, with gemmæ on the tips of the leaves, and forming aggregated cells; and *Tetraphis pellucida*, in which the gemmæ were enclosed in a lenticular bud.

The State Microscopical Society of Illinois.

October Meetings.

Regular meeting, Friday, the 1st. James V. Z. Blaney, Esq., M.D., Vice-President, in the chair.—Twelve members present. Visitors: A. A. Starr, of New York; Aldrich, of Marshallton, Iowa; Dr. Boyd. Correspondence: From Christopher Johnston, Esq., M.D., University of Maryland; Wm. B. Carpenter, Esq., M.D., F.R.S., University of London; J. B. Dancer, Esq., Manchester, England; Thomas Ross, Esq., Messrs. R. and J. Beck, and Messrs. Powell and Lealand, London; and Messrs. Field and Co., Birmingham, England. Donations: From Samuel Highley, Esq., F.G.S., London; Lieut.-Colonel Woodward, M.D., Army Medical Museum, War Department, Washington, D. C.; W. H. Walmsley, Esq., Philadelphia. Five new members proposed. Exhibited—By Starr: Living Animalculæ. Blaney: Crystals of Citric, tartaric, and oxalic acid. Boerlin: Field's Society of Arts Prize School and Student's Microscopes; also, the Child's Microscope, by the same maker.

Regular meeting, Friday, the 8th. James V. Z. Blaney, Esq., M.D., Vice-President, in the chair.—Nineteen members present. Five new members elected. Thirteen new members proposed. Dr. Blaney gave a brief and interesting account of the Spectroscope, its construction, uses, and importance to science, illustrating the several topics by exhibiting the instrument in working order.

Regular meeting, Friday, the 15th. Joseph T. Ryerson, Esq., in the chair.—Seventeen members present. Visitor: Mr. George Cook, of Newcastle-upon-Tyne, England. Thirteen new members elected. Walter Hay, Esq., M.D., read a paper "On the Adulteration of Coffee," showing the enormous extent and character of the frauds practised upon the public in this department of trade.

Regular meeting, Friday, the 22nd. Chas. G. Smith, Esq., M.D., in the chair.—Fifteen members present. One new member proposed.

Mr. Hankey read a paper "On a Microscope combining Excellence with Cheapness," introducing a Field's Society of Arts Prize Student's or Educational Microscope.

Regular meeting, Friday, the 29th. Samuel J. Jones, Esq., M.D., in the chair.—Twenty-five members present. Visitor: O. F. Fuller, Esq. New member elected: William M. Scudder. Mr. George M. Higginson gave a brief and interesting description of a fine Binocular Microscope made expressly for Albert A. Munger, Esq., by Mr. C. Baker, 243 and 244, High Holborn, London. Mr. Munger also exhibited a well-selected series of microscopical objects, prepared chiefly by Topping. The handsome cabinet, of polished mahogany, with plate-glass door, containing twenty-four drawers, in which the objects lay flat, was much admired by the members present.

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THE

MONTHLY MICROSCOPICAL JOURNAL.

FEBRUARY 1, 1870.

I.—*On the Stylet-Region of the Ommatoplean Proboscis.*

By W. C. McIntosh, M.D., F.R.S.E., F.L.S.

(*Read before the* Royal Microscopical Society, *December* 8, 1869.)
(Communicated by Dr. Murie.)

Plate XXXIX.

The proboscis, which various authors have burdened with functions so diverse in the economy of these curious worms—as an organ of touch, a penis, and an alimentary organ, or with bolder fancy have reckoned respectively a parasite and a young Nemertean—fortunately possesses, in the intricacy of its minute structure, sufficient interest to atone for this obscurity of action in the animal system. It forms a long and extremely mobile muscular tube, which has a special opening in front, and is attached by one or more muscular ribbons to the wall of its special sheath, which occupies the median line of the dorsum—quite above the alimentary canal—in all the Nemerteans. On the present occasion the abbreviated description will be confined to the central or proper stylet-region (B, Plate XXXIX.); the anterior and posterior regions (A and C) being for the moment overlooked.

EXPLANATION OF PLATE XXXIX.

Magnified View (as a transparent object) of the Stylet-Region of the Proboscis in *Ommatoplea alba*.

A, Anterior region.
B, Middle or stylet-region.
C, Posterior region.
α, Opening in the floor of the anterior chamber.
β, Stylets.
ξ, Fluid vesicle.
δ, Duct of stylet-sac.
ε, Chamber behind floor.
η, Doubling of the floor of the anterior chamber.
θ, Muscular setting of basal granular sac.
λ, Basal granular sac.
μ, Ejaculatory duct.
ν, Lateral stylet-sac.
ρ, Chamber of the reservoir.
τ, Looping muscles of reservoir.
τ o, Longitudinal muscular layer of reservoir.
φ, Posterior channel of communication.

II.—*On a Method of Measuring the Position of Absorption Bands with a Micro-spectroscope.*

By John Browning, F.R.A.S., F.R.M.S.

(*Read before the* Royal Microscopical Society, *January* 12, 1870.)

As the micro-spectroscope is constantly receiving new applications, both practical and scientific, thanks to the untiring ingenuity of Mr. Sorby, it is daily becoming more desirable that we should have a simple and accurate method of measuring the position of lines, or bands, in absorption spectra. It is true that Mr. Sorby has contrived an arrangement founded on strictly scientific principles, a method which overcomes the great optical difficulty arising from the irrationality of dispersion, and which enables observations and measurements made with different instruments and by different observers, to be compared successfully with each other.

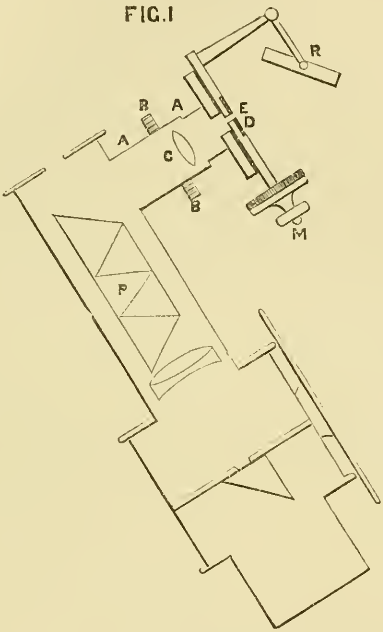
But Mr. Sorby's ingenious and accurate method of measurement does not find that favour with manipulators to which it appears to be entitled. There are various causes for this. It will be recollected that Mr. Sorby's plan consists in employing a thin plate of quartz placed between two Nicol's prisms. On bringing this arrangement in front of the slit of the micro-spectroscope, bands are produced in the spectrum by the interference of light, and the apparatus is contrived to give a number of bands that will divide the visible spectrum into twelve parts. The principal objections to this beautiful contrivance are, that it is an artificial scale, that it is very difficult of construction, and that if the quartz plate gets injured it cannot be repaired or replaced by any but a specially-trained workman, who understands the whole arrangement, and how it has to be used with the instrument.

Beyond this, as no figures, pointers, or other distinguishing marks, can be made to appear in the field of view by the side of the spectrum, frequent mistakes are made in counting the lines, particularly those near the middle of the spectrum. Urged repeatedly by many persons, and especially by Mr. Hogg, to undertake the task, I have contrived an arrangement which seems to avoid all the objections just enumerated, though it may be open to others which I have not foreseen.

I will now describe the apparatus, and then conclude with a brief account of the simple plan which I propose should be adopted to make all measurements taken with instruments of this kind comparable with each other.

Fig. 1 represents the upper part of the micro-spectroscope. Attached to the side is a small tube, A, A. At the outer part of this tube is a glass plate, blackened with a fine clear white line across the centre at right angles to the tube. This line can perhaps be most neatly produced by photography. I shall be glad to fall

FIG. I



back on Mr. Davies for assistance in this respect. The lens C, which is focussed by turning the milled ring M, produces an image of the bright line in the field of view by reflexion from the surface of the prism nearest the eye. On turning the micrometer M, the slide which holds the glass plate is made to travel in grooves, and the fine line is made to traverse the whole length of the spectrum.

I have described the micrometer as showing a single bright line, because it is thus shown in the engraving; but in practice it will be found better to employ two bright lines crossed at an angle of 45°, like a letter X.

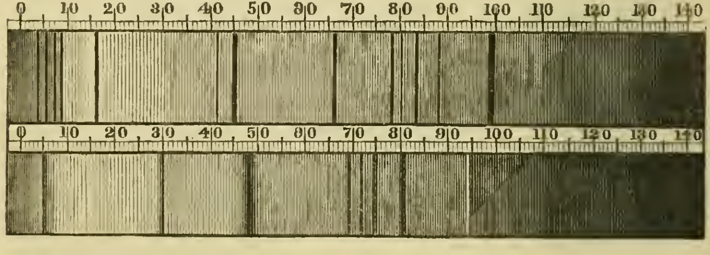
It might at first sight appear as if an ordinary spider's web or parallel wire micrometer might be used instead of this contrivance. But on closer attention it will be seen that as the spectrum will not permit of magnification by the use of lenses, the line of such an ordinary micrometer could not be brought to focus and rendered visible.

The bright line of the new arrangement possesses this great advantage—that it does not illuminate the whole field of view.

If a dark wire were used, the bright diffused light would almost obscure the faint light of the spectra, and entirely prevent the possibility of seeing, let alone measuring, the position of lines or bands in the most refrangible part of the spectrum.

To produce good effects with this apparatus the upper surface of the compound prism P must make an angle of exactly 45° with the sides of the tube. Under these circumstances the limits of correction for the path of the rays in their passage through the dispersing prisms are very limited and must be strictly observed. The usual method of correcting by the outer surface is inadmissible. For the sake of simplicity, some of the work of the lower part of the micro-spectroscope is omitted in the engraving. As to the method of using this contrivance: with the apparatus just described measure the position of the principal Fraünhofer's lines in the solar spectrum. Let this be done *carefully*, in *bright* daylight. A little time given to this measurement will not be thrown away, as it will not require to be done again. Note down the numbers corresponding to the position of the lines, and draw a spectrum from a scale of equal parts. About three inches will be found long enough for this spectrum ; but it may be made as much longer as is thought desirable, as the measurements will not depend in any way on the distance of these lines apart, but only on the micrometric numbers attached to them. Let this scale be done on cardboard and preserved for reference. Now measure the position of the dark bands in any absorption spectra, taking care for this purpose to use lamplight, as daylight will give, of course, the Fraünhofer lines, which will tend to confuse your spectrum. If the few lines occurring in most absorption spectra be now drawn to the same scale as the solar spectrum, on placing the scales side by side, a glance will show the exact position of the bands in the spectrum relatively to the Fraünhofer lines, which thus treated form a natural and unchangeable scale (see diagram). But for

Fig. 2.



purposes of comparison it will be found sufficient to compare the two lists of numbers representing the micrometric measures, simply exchanging copies of the scale of Fraünhofer lines, or the numbers representing them will enable observers at a distance from each other to compare their results, or even to work simultaneously on the same subject. The apparatus is here in operation this evening.

Dr. Lawson has suggested that it is a great advantage of this contrivance that it does not monopolize one of the two spectra, as is the case with the use of the quartz scale: for in describing two spectra, only slightly differing from each other, it may be used at once to determine the difference between them. Many substances give two different spectra when examined by transmitted or reflected light, though there is a generally close resemblance between them. This was the case in the instance of the dichroic fluid, kindly given me some time since for examination by our President, the Rev. J. B. Reade.

At the time I described the two spectra of this strange fluid before the Society, I felt a want of some simple method of indicating the differences between them. I hope to exhibit very soon before the Society coloured forms of blank spectra, that is, free from lines, as I think publishing these at a low price will facilitate the adoption of the plan and the use of the instrument.

III.—*On an Undescribed Stage of Development of Tetrarhynchus Corollatus.*

By Alfred Sanders, M.R.C.S., F.R.M.S.

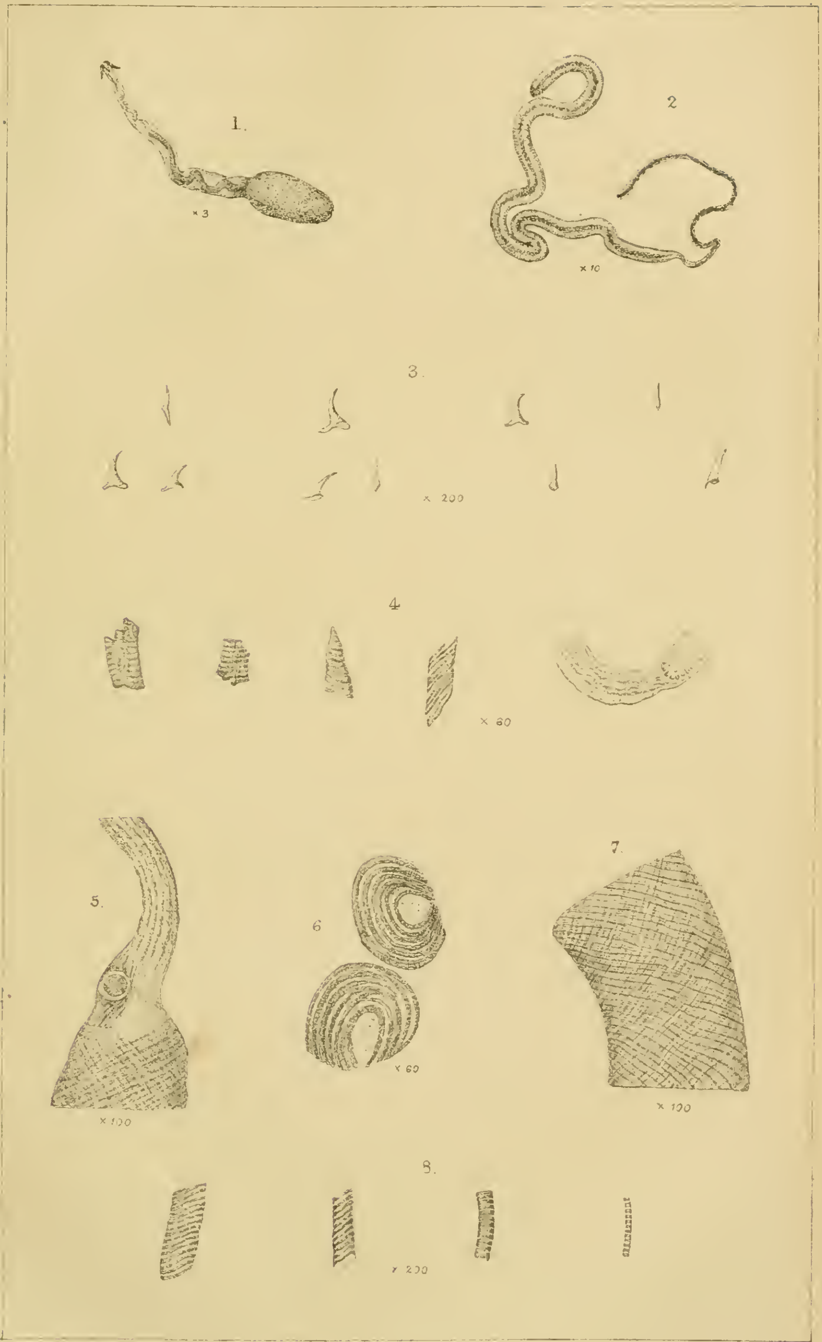
(*Read before the* Royal Microscopical Society, *January* 12, 1870.)

Plate XL.

Being engaged in the course of the autumn before last in researches which necessitated the dissection of a great number of the common Hermit Crab (*Pagurus Bernhardus*), I found in the tubules of the liver of one specimen numerous cestode worms which appeared to be remarkable; not having at the time leisure to pay attention to them, they were put aside in a solution of glycerine in water until a favourable opportunity should occur for investigating them more minutely. Before entering on an examination of the relations of this animal, I will give a description of its anatomy. Its total length is about 14^{mm}. It is divisible into a head, neck and body; the head and neck measure rather more than 9^{mm}, the body occupying the remainder; the head is provided with two regularly oval flaps approaching each other obliquely towards the anterior extremity, there leaving between them a space slightly convex, in which are situated the openings of four proboscides arranged in a quadrangular manner; the neck is long and slender, and tapers slightly towards the head; it contains the above-mentioned proboscides, which are the distinctive features in the anatomy of this animal. Each proboscis consists of three parts: the anterior contains a protrusile tube, whose parietes are separate and distinct from those of the proboscis itself, but which are continuous anteriorly; this tube is provided with numerous hooks, arranged in oblique rows; their bases are inserted into the inner surface of its walls, and their points are directed towards the centre, the whole arranged in such a manner that when the tube is exserted, it is turned inside out, so that the inner surface of the wall becomes the outer, and the points of the hooks are then directed outwards. The hooks vary greatly in size and shape, some being long and narrow, others short and

EXPLANATION OF PLATE XL.

Fig. 1.—Larva of *Tetrarhynchus Corollatus.*
,, 2.—One of the proboscides seen as a whole.
,, 3.—Hooks of various sizes and shapes.
,, 4.—Smooth fibres embracing the end of the dentigerous tube, the external envelope having been removed.
,, 5.—Smooth fibres entering muscular part of the tube, showing projection of wall.
,, 6.—Transverse section of muscular part, showing position of smooth fibres in tube.
,, 7.—Part of longitudinal section of same, showing direction and arrangement of fibres.
,, 8.—Separated portions of muscular fibre more highly magnified: in the lower row is the bevelled-off end of one fibre, others are seen breaking up into fibrillæ and disks.



A. Sanders del. Tuffen West sc. W. West imp.

Development of Tetrarhynchus corollatus.

(illustrating Mr. Sanders paper)

broad. In a general way the smaller ones are placed anteriorly, and the larger posteriorly; but if a transverse section be made, various sizes are found on the same level. In the substance of the wall of the tube are found longitudinal smooth fibres, which are collected into a bundle at its posterior extremity, and proceed backward for a short distance covered only by the general parietes of the proboscis. This forms the second portion. The smooth fibres after a short course enter the third part, which is the longest. If a transverse section be made of this part, it is found to consist of six layers of striated muscular fibres, enclosing the smooth fibres above mentioned. Each layer consists of a single fibre, forming as it were a complete muscle in itself. There are no tendons. The three outer layers do not make the whole circuit of the proboscis, but are bevelled off and inserted into the outer covering. The three inner are much smaller in diameter, and complete the circle, which their extremities touch. The consequence of this arrangement is that the smooth fibres are not in the centre, but rather on one side.

Longitudinally the striated fibres are arranged in close juxtaposition and are directed diagonally, their origin and insertion being at points anterior and posterior to each other; the layers cross each other at right angles, the first going from right to left, the next from left to right, and so on, the individual fibres varying in size from $0 \cdot 005^{mm}$ to $0 \cdot 032^{mm}$, the smallest forming the internal layers; they have a tendency to break up into disks and fibrillæ; their shape is either round, square, or with a sinuous contour; they recall to mind the muscular fibres of insects, but the elements are much larger; the smooth fibres extend quite to the posterior extremity of this portion. There is an external covering for the whole proboscis; over this part it is thin and membranous, and is only seen on a transverse section, but anteriorly it is very thick, and at the point where the smooth fibres enter, the third portion develops a round solid knob projecting internally, whose use is not apparent. If the whole structure were divided into 115 parts, the first part would occupy about 38 of those parts, the second part would take 7, and the third part 70. The body is tongue-shaped, and marked by minute transverse rugæ, and contains the usual elements of this class of animal. There are no traces whatever of any digestive or generative organs; the specimens were not enclosed in any cyst, but were found free, doubled up in the tubules of the liver, which being distended performed the office of cyst for the parasites, the position in which they were found having precluded all movement.

On looking over the literature of the subject, I found that the figure which most nearly resembled my specimen in the shape of the head was that of *Bothriocephalus Corollatus* of Rudolphi;*

* 'Historia Entozoorum,' Table ix., Fig. 12.

this species is also figured under the same name by Bremser,* with four fine lines running down from the anterior extremity; the specimen of Rudolphi was taken from *Raya Batis*, that of Bremser from the intestines of *Squalus Gallæus*. F. S. Leuckart† figured the same animal and called it *B. Planiceps;* the tentacles are represented protruding, and he mentions four fine lines or tubes, continuations of the tentacles, each ending in a little knob. J. Müller,‡ in speaking of these knobs and lines in another species, *T. Attennatus* from the Sword Fish, suggested that they might be the digestive organs. Von Siebold§ named this species *T. Corollatus*, and Blanchard‖ called it *Rhynchobothrius Corollatus*. Leblond¶ had before thought that he had found a Tetrarhynchus parasitic in a trematode worm, and Professor Miescher** considered that it was derived from a Filaria, which developed itself into a Trematode and then into a Tetrarhynchus; but Von Siebold†† clearly showed that both the supposed Filaria and the Trematode were stages in the development of one and the same animal, *viz. T. Corollatus*. Van Beneden‡‡ also described this stage, which he called scolex in much the same manner as Von Siebold. Desir§§ also gave a description of a very similar animal, which he called *Anthocephalus Scombri;* the figures slightly differ from those of the others, but his description evidently applies to the same species. None of these authors mention any animal exactly like my specimen; and although Van Beneden and Von Siebold, in speaking of a *T. Longicollis* from intestines of *Nurstelus Vulgaris*, describe very evident muscular fibres which cross each other diagonally, they say nothing of striated fibres, neither do their figures show any. On this point Rud Leuckart‖‖ remarks that "the muscular system of cestodes consists of smooth fibres grouped together in bundles more or less thick." In conclusion, I would remark that I consider my specimen to be an undescribed larva of *Tetrarhynchus Corollatus*, the head closely resembling in shape the head of that species when mature, as figured by Rudolphi, the fine lines and little knobs being the above-described proboscides atrophied from being no longer required for use when the animal had reached its ultimate habitat in the intestines of the Rays or Sharks; the scolex of Von Siebold and Van Beneden, being much smaller than mine, had not advanced so far in development.

* 'Icones Entozoorum,' Table x., Fig. 13.
† 'Bruchstücke Zoologisches,' Part I., s. 21.
‡ 'Müller's Archiv.,' p. cvi.
§ 'Z. W. Z.,' 1850, Bd. 2, p. 246; and 'A. S. N.,' 51.
‖ 'A. S. N.,' 49, tom. x., 3rd Series.
¶ 'A. S. N.,' 36, tom. vi.
** 'Bericht über verhandlungen der nat. forsch. Gesellschaft in Basel,' tom. iv., 40.
†† Loc. cit.
‡‡ 'Nouv. Mém. Acad. Roy. Belg.,' tom. xxiv., 50, p. 78.
§§ 'Archives de Médecine Comparée,' tom. i.
‖‖ 'Die Menschlichen Parasiten,' p. 168.

IV.—*On a New Instrument for Cutting Thin Sections of Wood.* By M. Mouchet, Hon. F.R.M.S.

(*Read before the* Royal Microscopical Society, *January* 12, 1870.)
(Communicated by the President.)

I have remarked often that thin sections of wood, when submitted to microscopic investigation, exhibited on one of their sides beards, owing to the wood offering a very slight resistance to the knife after having been cut through $\frac{2}{3}$rds or $\frac{3}{4}$ths of its diameter. I have been therefore induced to look for a remedy against this inconvenience, and I think I have found it. I am confident that the question consists in being able to cut the wood out the whole of its circumference.

The only difference between the former machine and the one which I have now made lies in this, that the knife cuts the wood circularly.

This knife has a very strong and semicircular blade, and is fixed by means of screws to a handle that is long enough to form a lever, the fastening-point lying in the upper part of the knife 5 centimètres distant from the centre of a copper-plate 19 centimètres in diameter. The surface of this plate is perfectly even, and the knife is, as it were, adherent to it.

This knife is sloped underneath in order to avoid rubbing, and kept in its place by a large-headed screw.

In the centre of the plate may be fixed, when and as one pleases, small tubes of different diameters, which tubes are to receive the stalks of wood that are to be cut. Underneath the plate there is a finely-notched wheel which, through a pinion and handle, causes the tube to be moved, and the wood contained in it, and destined to be cut in thin sections, to turn round.

The whole system previous to the operation is maintained in a press-vice, or fixed on the border of a table by a clamping-screw. In this way both hands are free, and while the right hand is acting on the knife-lever, the left manœuvres the pinion stalk-handle, and the wood is attacked circularly and easily cut to its centre. Complication is the only defect of the system; but it cannot be avoided where catchings are used. I hardly need say that in this little machine, as well as in all those of the same kind that are carefully made, the wood is brought forward by a micrometric screw, the head of which is divided in order to get the thin sections to have the thickness required.

In this too summary note I intend nothing else but to indicate the way in which wood is to be cut when wishing to avoid the *beards* which I have spoken of, and which many a one must have remarked in certain microscopic preparations.

Note.—At the President's request, M. Mouchet communicated this brief notice of his Cutting Machine, for which he received the "Gold Medal of Honour" at the late Paris Exposition.—Ed. M. M. J.

V.—*On the Calcareous Spicula of the Gorgonaceæ: their Modification of Form, and the Importance of their Characters as a Basis for Generic and Specific Diagnosis.* By Wm. S. Kent, F.Z.S., F.R.M.S., of the Geological Department, British Museum.

(*Read before the* Royal Microscopical Society, *January* 12, 1870.)

The subject of the present communication may be considered as one of peculiar interest to workers with the microscope, embracing as it does forms of exquisite outline only to be appreciated with the

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EXPLANATION OF PLATE XLI.

Figs. 1–3.—Squamose spicula of *Primnoa lepadifera* × 50.
„ 4–7.— „ „ „ *monilis* „
„ 8, 9.— „ „ „ *verticillaris* „
(The last closely assimilating the form of scale peculiar to the Ctenoid fishes.)
„ 10–12.—Squamose spicula of *Primnoa plumatilis* × 50.
„ 13.—Unsymmetrical irregular fusiform spiculum of *Muricea echinata* × 50.
„ 14, 15.— „ „ „ spicula of *Mur. lima.*
„ 16, 17.— „ arcuate, and echinato-clavate spicula of *Eunicea plantaginea*, Val. (*Muricea*), × 50.
„ 18, 19.—Laminato-proliferous and echinato-arcuate spicula of *Rhipidigorgia stricta*, M. Edw. (*Echinogorgia*), × 100.
„ 20, 21.—Laminato-proliferous and bi-aliform spicula of *Muricea fungifera*, M. Edw. (*Echinogorgia*), × 100.
„ 22, 23.—Laminato-proliferous and bi-rotulate spicula of *Rhip. coarctata*, M. Edw. (*Echinogorgia*), × 100.
„ 24.—Laminato-frondose spiculum of *Gorgonia granifera*, Lamk. (*Echinogorgia*), × 100.
„ 25.—Inflato-proliferous spiculum of *Leptogorgia aurantiaca*, M. Edw. (*Gorg. Danaidis*, Val.) (*Echinogorgia ?*), × 100.
„ 26, 27.—Irregular laminato-proliferous spicula of *Paramuricea placomus*, var. *a*, Klk. (*Acanthogorgia*), × 50.
„ 28–31.—Laminato-proliferous, attenuato-arcuate, and irregular fasciculate fusiform spicula of *Paramuricea placomus*, var. *b*, Klk. (*Acanthogorgia*), × 50.
„ 32, 33.—Irregular proliferous fusiform spicula of *Acanthogorgia Grayi*, Johnson, the first one exhibiting a tendency to become fasciculate at one extremity, × 50.
„ 34, 35.—Symmetrical tuberculate fusiform, and echinato-clavate spicula of *Eunicea laxispina*, M. Edw. Fig. 34 × 50, and 35 × 100.
„ 36, 37.—Symmetrical tuberculate fusiform, and echinato-clavate spicula of *Eunicea muricata*, M. Edw. Fig. 36 × 50, Fig. 37 × 100.
„ 38.—Laminato-clavate spiculum of *Plexaura pendula*, Val. (*Eunicea*), × 100.
„ 39.—Symmetrically tuberculate spiculum of an unknown species, probably belonging to the genus *Eunicea*, × 50.
„ 40–43.—Proliferous fusiform, and attenuato-stellate spicula of *Plexaura porosa*, M. Edw., × 100.
„ 44.—Bi-stellate spiculum of the same species × 100.
„ 45–46.—Proliferous fusiform, and bi-stellate spicula of *Plexaura fucosa*, M. Edw., × 100.
„ 47–50.—Bi, tri, and quadri-partite tuberculate spicula of *Plexaurella dichotoma*, Klk., × 100.
„ 51.—Attenuato-quadrangular spiculum from the same species, almost devoid of tubercles, × 100.


PRIMNOA
MURICEA
ACANTHOGORGIA
ECHINOGORGIA
PLEXAURA
EUNICEA
PLEXAURELLA

Spicules

assistance of that instrument. There are, I may safely presume, but few microscopists laying claim to the most modest collection of mounted slides who do not possess, in some form or other, prepared either as an opaque or transparent object, specimens labelled "Spicules of Gorgonia."

Now, considering there are several hundred species of so-called Gorgonias belonging to some score or more of distinct genera, such vague nomenclature as the above is unsatisfactory and indefinite in the extreme, and to the scientific mind simply painful.

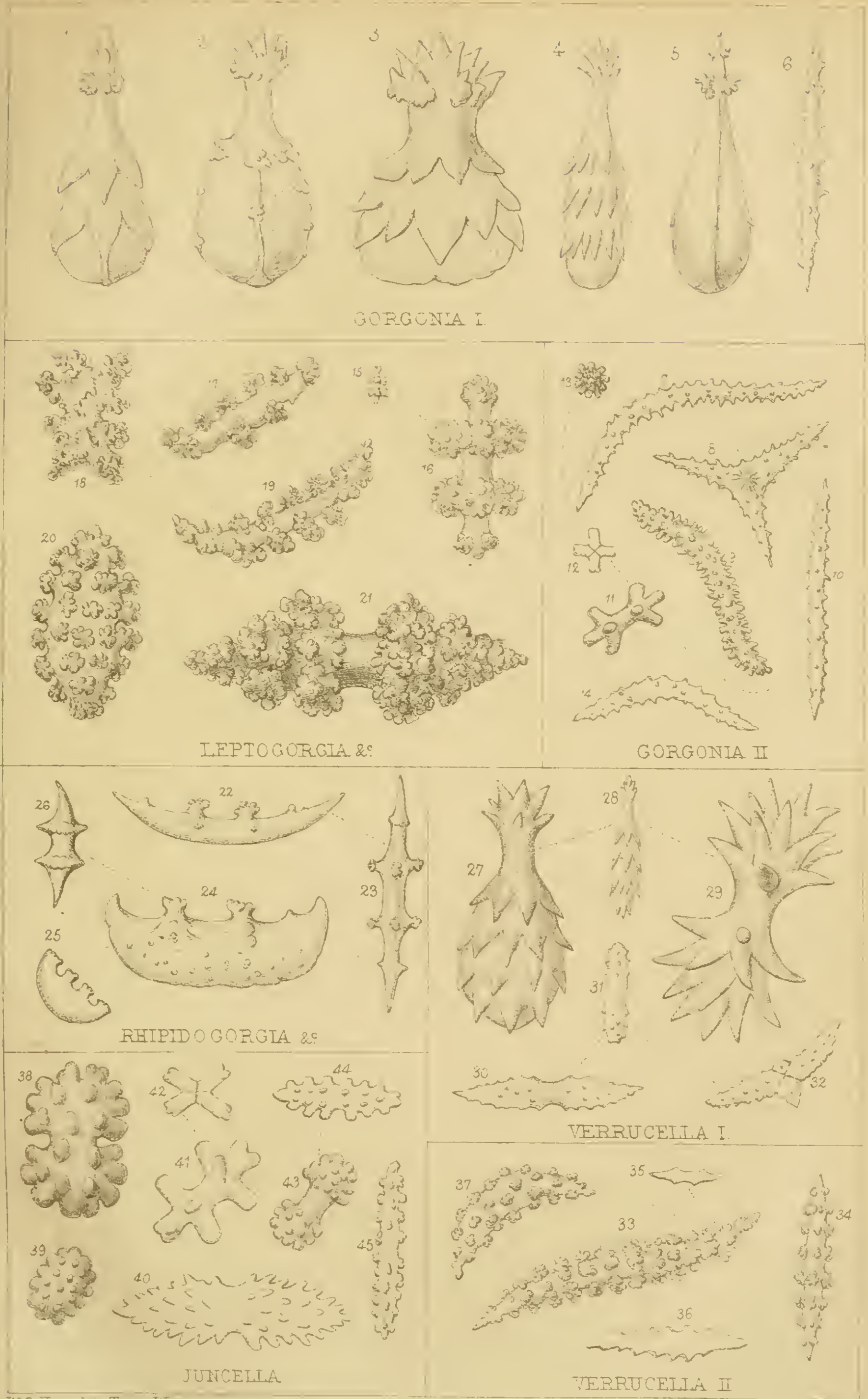
The slides of *Gorgonia* spicules usually offered for sale by the dealers contain for the most part neatly fusiform or more or less irregularly tuberculate spicula of a brilliant crimson lake, or transparent and colourless, with all the intermediate tints, and suggestive, for the want of a happier simile, of the brilliant sticks of pink and white sugar-candy, the admiration of our bygone, and perhaps lamented childhood.

Enticed, partly by the resolve to determine to which species the form just alluded to might be referred, but more especially by the desire of ascertaining to what extent the modifications in form of the various spicula might be made subservient as a basis for a natural system of classification of the whole group, and also to ascertain how far these modifications harmonized with the existing generic arrangement of species, I have recently devoted a short interval to the study of the *Gorgonaceæ*, both with regard to the structure of the spicula, and also to that of the entire organisms from whence they are derived.

The calcareous bodies or spicula of the *Gorgonidæ* have long been familiar to the naturalist, and as far back as 1786 our distinguished countryman, John Ellis, figured and described as "little purple glassy needles, irregularly but closely put together lengthways," the symmetrical fusiform bodies of which the entire axis of *Gorgonia briareus*, Ell. et Sol. (*Briareum gorgonideum*, M. Edw.), is composed. Another name, still more familiar to every microscopist, and whose numerous and exquisite preparations in the Museum of the Royal College of Surgeons bear ample testimony to the fervent zeal which animated him, is that of Professor Quekett. This gentleman devoted much time and attention to the study of the *Gorgonidæ*, and has figured and described numerous forms of spicula both in his 'Lectures on Histology' and in the 'Illustrated Catalogue' of the histological series contained in the museum referred to. But though different forms of these spicula have from time to time been referred to, it is only very recently that they have been studied with a view of making their characters available as a basis for a natural system of classification, and even then the majority of naturalists have arrived at the conclusion that though these characters might be made highly subservient as an aid to specific diagnosis, yet beyond this they were valueless. Such was the verdict of the eminent French naturalist Valenciennes, who, in the 'Comptes Rendus' for 1855, gave an abridged synopsis of the whole family, and described under five heads the leading types of spicula which had fallen under his notice, but unfortunately he was not spared to carry out to their completion the researches he had entered upon with so much zeal. A few years later (1857) the first volume of Milne Edwards' 'Histoire

EXPLANATION OF PLATE XLII.

Fig. 1.—Lagenate spiculum of *Gorgonia sp.* × 300.
" 2.— " " *papillifera*, M. Edw., × 300.
" 3.— " " *crinita*, Val., × 300.
" 4.— " " *sp.*, probably allied to *G. papillosa*, Esp., × 300. This drawing is enlarged from a figure given in 'Quekett's Lectures on Histology;' the remaining ones are, without exception, drawn from the original specimens.
" 5.—Lagenate spiculum of *Gorgonia racemosa* (*Plexaura do.*, Val.) × 300.
" 6.—Attenuato-fusiform spiculum of the same species × 100.
" 7, 8.—Arcuate and tri-radiate echinate spicula of *Gorgonia vatricosa*, M. Edw., × 100.
" 9.—Echinato-arcuate spiculum of *G. discolor*, M. Edw., × 100.
" 10.—Attenuato-echinate spiculum of *G. exserta*, M. Edw., × 100.
" 11, 12, 13.—Bi-stellate, quadri-partite, and nodular spicula of the same species, × 100.
" 14.—Echinato-arcuate spiculum of *G. arida*, M. Edw., × 100.
" 15.—Short tuberculate fusiform spiculum of *Lophogorgia palma*, M. Edw., × 100. This form is described in the text as the Leptogorgian type, it being predominant throughout *Leptogorgia* and many allied genera.
" 16.—The same spiculum × 400.
" 17.—Irregular fusiform spiculum of *Xiphigorgia setacea*, M. Edw., × 200.
" 18, 19.—Irregular fusiform spicula of *Leptogorgia viminea*, M. Edw., × 200.
" 20.—Ovato-tuberculate spiculum of *Pterogorgia suberosa*, M. Edw., × 200.
" 21.—Modified Leptogorgian type spiculum of *Hymenogorgia quercifolia*, M. Edw., × 300.
" 22, 23.—Lateral and front view of scaphoid spicula of *Pterogorgia setosa*, M. Edw., × 200.
" 24, 25.—Scaphoid spicula of *Rhipidigorgia flabellum*, M. Edw., × 200.
" 26.—Spiculum of the same species approaching the bi-rotulate form × 200.
" 27.—Lagenate spiculum of *Verrucella gemmacea*, M. Edw., × 300.
" 28.—A modification of the same form × 150.
" 29.—Spiked dumb-bell spiculum of the same species × 300.
" 30, 31.—Acutely and obtusely fusiform echinate spicula of *Gorgonia nodulifera*, Lamk. (*Verrucella?*), × 150.
" 32.—Spiculum of the same species assuming a quadri-partite outline × 150.
" 33, 34.—Tuberculato-fusiform spicula of *Verrucella violacea*, M. Edw., × 150.
" 35, 36.—Explanato-dentate spicula from the same species × 150.
" 37.—Tuberculato-fusiform spiculum of *Gorgonia sanguinolenta*, Val., × 150.
" 38, 39.—Mammillated dumb-bell and nodular spicula of *Juncella juncea*, M. Edw., × 150.
" 40.—Bi-partite echinate spiculum of *Pterogorgia betulina*, M. Edw., × 150.
" 41, 42.—Bi-stellate and quadri-partite spicula of *Juncella elongata*, M. Edw., × 150.
" 43.—Mammillated dumb-bell type spiculum of *Leptogorgia boryana*, M. Edw. (*Juncella*), × 150.
" 44.—Attenuate modification of the same type belonging to the same species × 150.
" 45.— " " of *Juncella caliculata*, Val., × 150. With these latter modifications the typical form, Fig. 38, is always associated.



W. S. Kent del. Tuffen West sc.

W. West imp.

Spicules of Gorgonaceæ

Naturelle des Corallaires' made its appearance, giving, in addition to an introduction to the organization of the *Actinozoa*, a systematic classification and description of the *Alcyonaria*, *Actinaria*, and *Antipathidæ*. In treating of the *Alcyonaria*, however, it is a matter of extreme regret that, except for a passing reference to the results arrived at by Valenciennes, no attention was paid by Milne Edwards, nor any value attached to the important histological characters afforded by the structure of the calcareous spicula which so abound in the sclerenchyma of this group.

For the latest, and without question the most important work that has yet appeared on the subject, Science is indebted to Professor A. Kölliker, who in a monograph entitled "Die Bindersubstanz der Cœlenteraten," in his 'Icones Histiologicæ' for 1866, enters fully into the modifications of the hard structures which obtain throughout the sub-kingdom, and devotes upwards of two magnificent quarto plates to the representation of the calcareous spicula of the *Alcyonaria* alone. He modifies to a considerable extent the plan of grouping into genera pursued by Milne Edwards, adopting in a great measure, as his foundation for doing so, the variation of form of the respective spicula. The results arrived at by Kölliker are principally based upon his examination of the type specimens of Esper and Duchassiang and Michelotti.

The study of a large series of spicula in my own possession, prepared from the type specimens of Valenciennes contained in the Paris Museum, the comparison of these with a similar collection in the Museum of the Royal College of Surgeons, together with the examination of a fine series in the same museum derived from other sources, and lastly, the consultation of the collections of dried specimens both in the College Museum and in the British Museum, has enabled me, in addition to corroborating to a great extent the results arrived at by Professor Kölliker, to add testimony of my own regarding a number of species not referred to in his very excellent monograph, as likewise to refer to their true zoological position numerous species of Valenciennes of whose affinities Milne Edwards stood in doubt.

Before proceeding to further details, a brief outline of the system of classification of this order now most generally accepted, including the organisms which form the subject of this present communication, will obviate the necessity of future repetition.

This order, the *Alcyonaria*, belongs to a sub-kingdom, the *Cœlenterata*, of which the Sea-anemone, the Fresh-water Hydra, and the Jelly-fish are the most familiar and instructive types.

The *Alcyonaria* are Anemone-like Cœlenterates, which, in their normal condition, invariably possess neither more nor fewer than eight tentacles, which are without exception to a greater or lesser extent pinnate.

For the formation of this very natural order we are indebted to the labours of MM. Audouin and Milne Edwards, as also for its sub-division into the three equally natural families of the *Alcyonidæ*, the *Gorgonidæ*, and the *Pennatulidæ*. The types of these three families in consecutive order would be the *Alcyonium*, or "Dead Man's Fingers;" *Corallium rubrum*, or the "Red Coral" of commerce, and the *Pennatula*, or "Sea-Pen."

The family of the *Gorgonidæ*, or rather a limited section of it, being the one to which it is my intention to confine my present observations, further reference to the two remaining groups would be superfluous. The following is an abstract of the division of the *Gorgonidæ* into sub-families, sections, and genera adopted by Milne Edwards in his 'Histoire Naturelle des Corallaires.'

Fam. GORGONIDÆ. M. Edw.

Alcyonaria, possessing a compound, adherent polypary; provided with a sclerenchyma of a suberose consistence, disposed after the manner of bark around a sclerobasic axis, which axis assumes the form of a simple stem or ramifying branch.

Sub-Fam. I. Gorgoninæ.

Gorgonidæ, whose common sclerobasic axis is for the most part or entirely flexible, and is either of the consistence of horn or suberose.

Sec. I. *Primnoaceæ.*

Gorgoninæ, whose sclerobasic axis is complete and tree-like, and whose sclerenchyma is armed with spines or squamiform spicula.

Gen. I. *Primnoa.*

Sp. 1. lepadifera.
2. antarctica.
3. verticillaris.
4. flabellum.
Sp. 5. plumatilis.
6. gracilis.
7. myura.

Gen. II. *Muricea.*

Sp. 1. spicifera.
2. lima.
3. elongata.
Sp. 4. echinata.
5. fungifera.
6. placomus.

Doubtful species: *Gorgonia scabra*, Val.; *G. cerea*, Esp.; *G. furfuracea*, Esp.

Sec. II. *Gorgonaceæ.*

Sclerobasic axis complete, dendroid, corneous; sclerenchyma, suberose or smooth.

Gen. III. *Eunicea.*

Sp. 1. laxispina.
2. muricata.
3. intermedia.
4. Castelnaudi.
5. multicauda.
6. crassa.
Sp. 7. humilis.
8. asperula.
9. Tourneforti.
10. Rousseaui.
11. plantaginea.

Doubtful species: *Gorgonia pseudo-antipathes*, Lamk.; *G. madrepora*, Dana.; *G. succinea*, Esp.; *Eunicea clavaria*, Lamx.; *Eu. quincunualis*, Ehr.

Gen. IV. *Plexaura.*

Sp. 1. racemosa.	Sp. 7. rhipidalis.
2. flavida.	8. homomalla.
3. salicornoides.	9. friabilis.
4. flexuosa.	10. porosa.
5. fucosa.	11. vermiculata.
6. suffruticosa.	

Doubtful species: *Gorgonia trichostemma*, Dana.; *G. nodulifera*, Lamk.; *G. alba*, Lamk.; *G. anguicula*, Dana.; *Plexaura olivacea*, Lamx.; *Plx. arbusculum*, Duchass. et Mich.; *Plx. brevis*, D. et Mich.

Gen. V. *Gorgonia.*

Sp. 1. vatricosa.	Sp. 8. pumicea.
2. arida.	9. ramulus.
3. venosa.	10. discolor.
4. verrucosa.	11. papillifera.
5. subtilis.	12. amaranthoides.
6. exserta.	13. graminea.
7. miniata.	14. citrina.

Doubtful species: *G. Bertholoni*, Lamx.; *G. Rissoana*, Delle Chiaje; *G. Gallardi*, Duchass.; *G. fusco-purpureo*, Ehr.; *G. leucostoma*, Ehr.

Gen. VI. *Leptogorgia.*

Sp. 1. viminalis.	Sp. 8. viminea.
2. cauliculus.	9. aurantiaca.
3. miniacea.	10. sanguinea.
4. rosea.	11. virgulata.
5. purpuracea.	12. Boryana.
6. porosissima.	13. virgea.
7. Webbiana.	

Doubtful species: *Gorgonia purpurea*, Pall.; *G. Sasappo*, Pall.

Gen. VII. *Lophogorgia.*

Sp. palma (*Gorgonia flammea*, Ell. et Sol.).

Gen. VIII. *Pterogorgia.*

Sp. 1. setosa.	Sp. 5. suberosa.
2. pinnata.	6. petechizans.
3. Sloanei.	7. laxa.
4. Ellisiana.	8. betulina.

Doubtful species: *Pt. stricta*, Ehr.; *Pt. sancti-Thomæ*, Ehr.; *Gorgonia patula*, Ell.; *G. citrina*, Esp.; *Pt. fasciolaris*, Ehr.

Gen. IX. *Xiphigorgia.*

Sp. 1. anceps.	Sp. 2. setacea.

Doubtful species: *Pterogorgia Guadalupensis*, Duchass. et Mich.

Gen. X. *Rhipidigorgia.*

Sp. 1. flabellum.
2. reticulum.
3. cribrum.
4. occatoria.
5. umbella.
6. arenata.
7. verriculata.
8. stenobrachis.
9. ventalina.
Sp. 10. elegans.
11. lacuens.
12. plagalis.
13. umbraculum.
14. stricta.
15. coarctata.
16. cancellata.
17. retellum.
18. venusta.

Doubtful species: *Eunicea apiculata*, Ehr.; *Eu. arbuscula*, Ehr.; *Gorgonia umbratica*, Esp.; *G. paradoxa*, Esp.; *Eunicea granulata*, Ehr.

Gen. XI. *Phyllogorgia.*

Sp. 1. dilitata.
Sp. 2. foliata.

Gen. XII. *Hymenogorgia.*

Sp. quercifolia.

Gen. XIII. *Phycogorgia.*

Sp. fucata.

Sec. III. *Gorgonellaceæ.*

Sclerobasic axis complete, dendroid, cerato-calcareous; sclerenchyma suberose or smooth.

Gen. XIV. *Gorgonella.*

Sp. 1. sarmentosa.
Sp. 2. verriculata.

Doubtful species: *Gorgonella cauliculus*, Val.

Gen. XV. *Verrucella.*

Sp. 1. violacea.
2. flexuosa.
Sp. 3. furcata.
4. gemmacea.

Gen. XVI. *Ctenocella.*

Sp. pectinata.

Gen. XVII. *Juncella.*

Sp. 1. juncea.
2. vimen.
Sp. 3. hystrix.
4. elongata.

Doubtful species: *Juncella surculus*, Val.; *J. caliculata*, Val.

Sec. IV. *Briaraceæ.*

Sclerobasic axis incomplete, represented by a deposit of suberose tissue, or by an aggregation of spicula.

Gen. XVIII. *Briareum.*

Sp. gorgonideum.

Gen. XIX. *Solanderia.*

Sp. gracilis.

Sub-Fam. II. Isidinæ.

Sclerobasic axis articulate, presenting segments whose composition is alternately dissimilar.

Gen. XX. *Isis.*

Sp. 1. hippuris.
2. polyacantha.
3. moniliformis.
4. coralloides.
Sp. 5. elongata.
6. melitensis.
7. spiralis.
8. corallina.

Gen. XXI. *Mopsea.*

Sp. 1. dichotoma.
2. encrinula.
Sp. 3. gracilis.
4. erythræa.

Gen. XXII. *Melithœa.*

Sp. 1. ochracea.
2. coccinea.
3. retifera.
Sp. 4. textiformis.
5. tenella.

Sub-Fam. III. Corallinæ.

Sclerobasic axis entirely stony.

Gen. XXIII. *Corallium.*

Sp. 1. rubrum.
2. secundum.
Sp. 3. Beckii.
4. pallidum.

The section of the *Gorgonidæ* to which it is my intention to confine my present observations corresponds to the first three sections of the sub-family *Gorgoninæ* in the foregoing schedule of classification. This group appears to me to be a very natural one, comprising as it does all those Gorgonias which share in common an inarticulate sclerobasic axis, and into which horny matter known as corneine enters to a greater or less extent.

For convenience sake I have provisionally applied to this group the term *Gorgonaceæ*, although it does not find its exact equivalent in the rendering of the same word as made use of either by Milne Edwards or Professor Kölliker.

Commencing at the head of the appended list, I shall now proceed to describe, seriatim, the various modifications in external contour and internal histological structure which are found to obtain in the respective genera.

Primnoa.—This genus, the most elegant perhaps of the whole family, is at once recognized by its pedunculated calices, which are armed with imbricated scales: the principal forms these scales or modified spicula assume are shown at Plate XLI., Figs. 1–12: the corneous sclerobasic axis in this genus contains, in addition, a large amount of carbonate of lime. The cœnenchyma or intercalicinal cortical matter is very little developed. Of the seven species alluded to by Milne Edwards (leaving out *P. gracilis*, which I have not yet had an opportunity of examining) all possess modifications of the same typical squamose spicula with the exception of *P. myura*. The polypary in this species is described as assuming the form of a simple rod, and having the calices disposed in two rows on each side of a median furrow; this external contour of the polypary corresponds to what obtains in the genus *Juncella* and its allies, and the spicula harmonizing exactly with the type-form peculiar to that genus, it seems highly probable that it ought to be incorporated in it. Kölliker does not refer to either *Primnoa plumatilis* or *P. gracilis* of Milne Edwards, but testifies to the new species *P. regularis* of Duchassiang and Michelotti possessing the type spicula of the genus.

Muricea.—Polypary branching; sclerobasic axis horny; sclerenchyma armed with coarse echinate spicula; calices approximate, very prominent, echinate. The dominant form of spicula in this genus is coarse echinate unsymmetrical fusiform, having spines or tubercles developed to a much greater extent on one side than on the other (Plate XLI., Figs. 13–15). In addition, more evenly tuberculate and echinate spicula of smaller size are abundantly represented.

Gorgonia plantaginea of Lamarck is referred by Milne Edwards to the genus *Eunicea*; the spicula prepared from Valenciennes types are, however, essentially characteristic of what obtains in *Muricea*, and the examination of specimens of the polyparies in the British Museum and that of the Royal College of Surgeons justifies me in referring the species without hesitation to the last-named genus. The spicula of *Gorgonia sectilis*, Val., also follow the Muricean type.

Kölliker annexes to this genus *Muricea elegans*, Duch. et Mich., and *M. horrida*, Mobius.

Muricea placomus, M. Edw. et Val. (non Esp.), is described by Milne Edwards as possessing a general form closely resembling that of *Gorgonia verrucosa*. Spicula prepared from the type specimens in the Paris Museum exactly agree with the form prevalent in the last-named genus, and to which it should doubtlessly be referred.

Echinogorgia, Klk.—The two species *Gorgonia cerea* and *furfuracea* of Esper, referred with doubt to the genus *Muricea* by Milne Edwards, together with *G. Sasappo* (*Rhip. stricta*, M. Edw.), its variety *reticulata*, and *G. umbratica* of the same author, have been formed into a new genus by Kölliker, to which he has given the name of *Echinogorgia*.

This genus appears to be a very natural one, and all its members share in common, spicula of a peculiar form; these may be described as consisting of a laminate or more or less expanded base surmounted by a coronet of variously modified proliferous prolongations (Plate XLI., Figs. 18, 20, 22).

In addition to the species above mentioned, I would also refer to this genus two others not alluded to by Kölliker: these are, *Rhipidigorgia coarctata*, M. Edw. (*G. coarctata*, Lamk.), and *Muricea fungifera* of the same author. The spicula of *Gorgonia granifera*, Lamk., which neither Milne Edwards nor Kölliker refers to, also harmonize with the *Echinogorgian* type just described.

With the typical spicula last alluded to, a simple echinulate arcuate form, not referred to by Kölliker, appears to be constantly present (Plate XLI., Fig. 19). This form of spicula is present in all the three last-mentioned species, and also in *Rhipidigorgia stricta*, M. Edw. (*Echinogorgia Sasappo*, Klk.).

Gorgonia Danaidis, Val., described by Milne Edwards as *Leptogorgia aurantiaca*, likewise possesses spicula approaching the proliferous type just alluded to (Plate XLI., Fig. 25). The base of these spicula, however, may be described rather as irregularly inflated than laminate; and the arcuate form not being represented, it seems probable that this species may eventually form the type of a new genus.

Acanthogorgia, J. E. Gray (*Paramuricea*, Kölliker). — Kölliker eliminates from the genus *Muricea* yet another genus, taking for his type the *Mur. placomus* of Ehrenberg (*Gorg. do.*, Esp.); an allied species, however, had previously been described by Dr. Gray, who attached to it the generic name of *Acanthogorgia*, and which name must necessarily take the precedence of the one more recently proposed by Kölliker. Comparisons of the spicula of *Acanthogorgia Grayi*, J. Y. Johnson, and *Muricea placomus*, Ehr., demonstrate beyond doubt their generic identity. The spicula of the various species of *Acanthogorgia* possess well-marked specific characteristics. All share in common an arcuate type, as in *Echinogorgia*, but they may be distinguished by being more slender and less abundantly echinulate than those of that genus; the remaining spicula differ considerably according to their species; with all, however, there is a certain raggedness of outline rendering them readily distinguishable from those of any other genus. The two forms of *Paramuricea placomus*, Kölliker, treated as simple varieties by the last-named author, are undoubtedly two distinct species. In his variety *a*, the calices are large and closely approximated on the polypary, while in his variety *b*, they are considerably smaller and sparsely scattered; the variation in the character of their respective spicula is still more prominent. The first-named variety contains in abundance the form with modifications represented at Plate XLI., Figs. 26, 27: a proliferous type, having laminate prolongations developed on the same plane and whose margins are more or less lacinulate and echinate; one of these prolongations is usually produced in the form of a taproot to a much greater length than the others.

In variety *b*, two very distinct forms prevail in addition to the usual arcuate type: the one (Plate XLI., Figs. 28, 29) bears a certain resemblance to the form predominant in variety *a*, but the taproot-like prolongation is here represented by a small fascicle of rootlets or series of laminæ whose axis is produced at right angles to the plane on which the remaining ones subtend; this peculiarity of their arrangement gives these spicula a very plant-like aspect. The remaining form (Plate XLI., Fig. 31) is easier figured than described; it seems, however, to be an extraordinary development of an irregular echinate fusiform type, one end of which has become fasciculate, while the other gives rise to a variable number of lacinulate prolongations; this interpretation is the more easily understood on reference to the spicula of *Acanthogorgia Grayi* (Plate XLI., Figs. 32, 33). Here, in addition to the slender arcuate form, irregular echinate and more or less lacinulate fusiform spicula form the prevailing type, some of these, moreover, evincing a tendency to become fasciculate at one extremity.

Paramuricea intermedia and *spinosa*, Klk., and *Villogorgia nigrescens*, Duch. et Mich., according to Kölliker, possess the generic characters of the foregoing varieties of *placomus*, and are referred by him to the same genus.

Eunicea.—Polypary branching, axis corneous; sclerenchyma of a suberose consistence, calices very prominent, cylindrical, the apertures usually bilabiate.

The characteristic form of the spicula in this genus is represented at Plate XLI., Figs. 34, 36. These for the most part consist of large, handsome, evenly tuberculate fusiform spicula of various colours, and include the form usually prepared for sale, referred to at the commencement of this paper: these spicula occupy the deeper part of the cœnenchyma; superficial to them is a cortical layer of variously modified echinate or furcato-clavate spicula, of which examples are shown at Plate XLI., Figs. 35, 37, 38. To this genus should doubtlessly be referred *Plexaura pinsilis* and *pendula*, from the Antilles, of Valenciennes, but to which two species no reference is made by either Milne Edwards or Kölliker. The last-named author substantiates the claim of *Gorgonia succinea*, Esp., and *Eunicea clavaria*, Lamouroux, to be ranked as true *Euniceæ*. Milne Edwards was not altogether certain of their true position. In addition, Kölliker includes the following new species in the same genus:—*Eunicea hirta*, *Stromeyeri*, *fusca*, *Sagoti*, and *lugubris*, Duch. et Mich., and *E. mammosa*, Lamouroux. *Eunicea plantaginea* of Milne Edwards has already been referred to the genus *Muricea*. The spicula of *Gorgonia pseudo-antipathes*, Lamk. (non Esp.), essentially follow the Eunicean type.

Plexaura.—Polypary branching, axis corneous; cœnenchyma extremely thick, of a suberose consistence; calices not prominent.

The predominant type of the spicula in this genus appears to originate from an irregular tuberculate fusiform condition, which evinces a tendency to become eminently proliferous (Plate XLI., Figs. 40, 41). Associated with these, attenuato-bistellate and echinato-clavate spicula are of frequent occurrence, these latter occupying the superficial layer of the cœnenchyma.

Plexaura racemosa, Val. et M. Edw., possesses spicula corresponding exactly to what obtains in Gorgonia proper, and to which genus it should in all probability be referred; additional evidence in support of the proposed re-arrangement of this species is furnished by Milne Edwards' remark that it seems to establish the passage between the genera *Eunicea* and *Gorgonia*.

Gorgonia alba, Lamk., referred with doubt to Eunicea by Milne Edwards, contains spicula agreeing essentially with the type predominant in *Leptogorgia* to be afterwards described, and to which genus it is probably referable. The spicula of *Plexaura eburnea*, Val., not alluded to by Milne Edwards, also agree with the same type.

Gorgonia nodulifera, Lamk. (*Plexaura* (?) M. Edw.), abounds with spicula agreeing with a form predominant in *Verrucella gemmacea*, and which will be again referred to when describing those of that species. Kölliker retains this species in the genus *Plexaura*, but probably had not an opportunity of consulting the type specimens; he likewise adds to it *Plexaura Ehrenbergii*, Kl., *P. antipathes*, Kl. (*Gorgonia*, Esp.), and *P. dubia*, Kl. (*G. antipathes*, var. Esp.).

Plexaurella, Klk., *Plexaura dichotoma* and *vermiculata*, M. Edw., with other allied species, have been formed into the new genus *Plexaurella* by Kölliker, on account of the difference they present in the structure of their axis and in the contour of their spicula from all the ordinary *Plexauræ*. The axis in this genus contains a large amount of carbonate of lime, and the spicula are very characteristic. These last assume a bi- tri- or quadri-partite outline, the latter form often bearing a strong resemblance to some elegant tropical Papilio. They are for the most part more or less bilaterally symmetrical, having a smooth zone in the centre, with richly tuberculated alæ on either side. Characteristic forms from *Plexaurella dichotoma* are represented at Plate XLI., Figs. 47–51.

To the species already referred to, Kölliker annexes *Plexaurella crassa* (*Gorgonia*, Esp.), *Plexaurella anceps* and *nutans* (*Eunicea* of Duch. et Mich.), and *Gorgonia furcata*, Lamk. To these should evidently be added *Gorgonia heteropora*, Lamk. (*Plexaura* of Lamx.), the spicula in this species agreeing precisely with the form predominant in *P. dichotoma*.

Gorgonia.—Polypary arborescent, more or less flabellate, branching irregular dichotomously; ramuscules free, almost cylindrical.

Cœnenchyma moderately thick, rarely presenting a well-marked median furrow. Calices occupying the summit of prominent verruciform tubercles. The examination of type spicula of eleven out of fourteen of Milne Edwards' species of *Gorgonia* proper, enables me to separate his genus into three very distinct groups.

Sec. I.—Taking as the type of the first group the *Gorgonia verrucosa* of Linnæus, common on our British coasts, the spicula are found to consist essentially of two forms, the one being attenuate fusiform and sparsely echinate, and the other, and most characteristic one, lagenate or flask-shaped, the head of the flask being to a greater or less extent tuberculate, and the bulb usually exhibiting a tendency to become either fluted or verticillate. These lagenate spicula occupy the surface of the cœnenchyma, the base being directed outwards. Kölliker, plate xviii., figs. 25 and 26, shows a transverse section of the polypary of an allied species illustrating the position of these spicula *in situ.*

Gorgonia papillifera, amaranthoides, and *graminea,* M. Edw., harmonize with *G. verrucosa* in possessing spicula of precisely the same character. To these must be added the three following species which have been referred to other genera by the author just quoted, *i. e., Muricea placomus,* Val. et M. Edw. (non Esp.), *Plexaura racemosa,* Val., and *Verrucella furcata,* M. Edw. (*Gorgonia,* Lamk.). *Gorgonia crinita,* Val., not alluded to by Milne Edwards, must also be annexed to the same group. In accordance with Kölliker, *Gorgonia venosa* and *subtilis,* Val., *G. papillosa,* Esp., *G. Bertolonii,* Lamx. (*G. viminalis,* var. Esp.), and *G. albicans,* Klk. (*G. palma,* var. Esp.), likewise possess spicula of the character just described. Examples of the spicula characteristic of this group are shown at Plate XLII., Figs. 1–6.

Sec. II.—*Gorgonia, vatricosa, arida, discolor,* and *exserta* of Milne Edwards agree in possessing spicula almost entirely of a slender arcuate form, and to a greater or lesser extent tuberculate or echinate. Plate XLII., Figs. 7, 9, 14, *G. exserta,* diverges rather from the other three in having spicula which are less arcuate and more attenuate, and which approach to a doubly-stellate form. These four species, with their characteristic spicula, are omitted by Kölliker in his Monograph.

Sec. III.—*Gorgonia miniata, pumicea* and *ramulus,* M. Edw., possess spicula essentially characteristic of what obtains in the genus *Leptogorgia* to be next described.

Leptogorgia. Axis corneous; cœnenchyma pellicular, compact; calices not prominent. The apertures of the calices being even with the surface of the cœnenchyma is suggestive of what obtains in the genus *Plexaura;* but the slender nature of the cœnenchyma, apart from the characters afforded by the spicula, renders this genus easily distinguishable from it.

With the small development of the cœnenchyma just alluded to, a corresponding minuteness in the size of the spicula might be reasonably anticipated; and the fact that the members of the genus and its allies contain smaller forms than are to be met with in any other, scarcely takes us by surprise. The type predominant throughout the *Leptogorgiæ* is represented at Plate XLII., Figs. 15, 16, consisting of short fusiform spicula, bearing two, four, or more transverse rows of tuberculæ. This form is constant in the following species of Milne Edwards which I have had the opportunity of examining, *i. e.*, *L. rosea*, *Webbiana*, *viminea*, *sanguinea*, *virgulata*, and *virgea*. Exceptional forms occur in *L. Boryana* and *aurantiaca;* the former possessing a type peculiar to *Juncella*, to be hereafter described; and the latter, one closely assimilating that prevalent in *Echinogorgia*, and with which it was associated when referring to that genus.

The Leptogorgian type of spicula is very widely disseminated, and crops up with various modifications and associations in each of the following genera of Milne Edwards, *viz. Lophogorgia*, *Pterogorgia*, *Xiphigorgia*, *Rhipidigorgia*, *Phyllogorgia*, *Hymenogorgia*, *Phycogorgia*, and *Gorgonella*.

This relative conformity of the spicula has induced Kölliker to group the representatives of the majority of these genera (*Phyllogorgia* and *Phycogorgia*, to which he makes no reference, being alone excepted) under the one generic title of *Gorgonia*. He, moreover, incorporates with these those true *Gorgoniæ* possessing the attenuate fusiform and lagenate spicula before described. His motive for this last arrangement is quite inexplicable, and is certainly not a natural one, since it includes organisms differing most essentially in both their external contour and internal structure.

Proceeding with the system of classification adopted by Milne Edwards, the next genus we arrive at is *Lophogorgia*, and which he characterizes as follows:—

Lophogorgia.—Polypary spread out in the form of a plume or fan, having one or more of the branches thick and flattened.

The spicula of the single species, *L. palma*, essentially follow the Leptogorgian type; and though the main branches of the polypary are thick and flattened, it is a significant fact that the terminal ones are slender and cylindrical, and beset with minute slit-like polyp apertures precisely similar to what we meet with in the genus *Leptogorgia*.

Pterogorgia.—Polypary ramifying or bi-pinnate, flattened, having the calices disposed on the two surfaces in longitudinal series on each side of a median line.

All the species of this genus that I have examined contain spicula agreeing with the Leptogorgian type; several of them, however, possess different forms in association with this type.

In *Pterogorgia setosa*, for instance, we for the first time meet with an arcuate form bearing tuberculæ only on the inner surface of the arc (Plate XLII., Fig. 22). These viewed in profile bear a grotesque resemblance to a canoe fully manned, and for which reason I shall hereafter distinguish this form of spicula by the appellation of the scaphoid type.* Mixed with these, in *P. setosa*, is the Leptogorgian type before referred to. *Pt. pinnata* also possesses the two forms which obtain in the last-named species. *P. suberosa* and *betulina* possess, in addition to the Leptogorgian type, spicula of a somewhat ovate form (Plate XLII., Fig. 20); and with the latter are also included an approach to the *Juncella* and spiked dumb-bell type.† The spicula of *P. petechizans* and *laxa* also follow the Leptogorgian type, but are rather irregular.

Xiphigorgia.—Polypary having the sclerobasic axis bordered on each side by a lateral expansion of the cœnenchyma; the calices disposed in vertical rows on the edges of these laminæ.

The Leptogorgian type of spicula, with minor modifications, is predominant in both species of this genus; *X. anceps* possessing in addition an approach to the scaphoid type.

Rhipidigorgia.—The branches of the polypary in this genus are not only disposed on the same plane, but the ramuscules coalesce at every point of contact, so as to constitute a more or less perfect network. This form of polypary has won for them the popular appellation of "Sea-Fans."

Milne Edwards refers to this genus all the *Gorgonaceæ* exhibiting a tendency to become reticulate; but as such an arrangement necessarily binds together a series of species presenting the most marked differences in the structure and arrangement of their calices, in the contour of their respective spicula, and, in all probability, in that of the polyp-animals themselves, the genus, as at present constituted, cannot take rank as a natural one.

The following are the principal modifications in form of the spicula of the species I have so far examined:—

1. *Rhipidigorgia flabellum* and *occatoria* agree in possessing the Leptogorgian and scaphoid type combined.

2. *R. reticulum, cribrum, arenata, verriculata,* and *stenobrachis* abound in the Leptogorgian type alone.

3. *R. lacuens, plagalis,* and *umbraculum* differ in possessing the form peculiar to *Juncella*.

4. *R. stricta* and *coarctata* vary again in the possession of an arcuate in conjunction with a laminato-proliferous type, referred to when describing *Echinogorgia*, and in which genus they were then included.

* Kolliker distinguishes this as the "cramp-iron" form "*klammer*," but the simile seems scarcely definitive.

† Subsequent examination has led me to refer this species to *Juncella*.

Phyllogorgia.—Polypary explanate, foliaceous; the sclerobasic axis branching, and the more slender ramifications anastomosing frequently among themselves, as with the genus *Rhipidigorgia*, the cœnenchyma, however, not constituting a cylindrical cortex around the axes, but expanding laterally, so as to form large foliaceous lamina, on the surfaces of which the calices are disposed.

In *P. dilitata* the Leptogorgian and scaphoid types of spicula predominate. *Phyllogorgia foliata* is described as closely approximating the last-named species; but I have not yet had an opportunity of examining its spicula.

Hymenogorgia.—The only difference existing between this genus and the last is, that the minor ramifications of the sclerobasic axis do not coalesce. The cœnenchyma forms similar foliaceous expansions, and the spicula follow essentially the same type.

Phycogorgia.—In this genus the sclerobasic axis itself becomes dilated in membranous expansions, resembling a *fucus* invested with a slender and porous cœnenchyma. One form of spicula alone is represented in the single species, *P. fucata*, and that the regular Leptogorgian type.

The four next genera have been separated by Milne Edwards into a distinct group, the *Gorgonellaceæ*, on account of the sclerobasic axis containing a large amount of calcareous in addition to corneous matter; he considers, however, that they respectively correspond to certain genera of the *Gorgonaceæ* (M. Edw.) possessing entirely corneous axes. Kölliker, as has been already observed, has made, partly for the same reason, a similar separation of several species from *Plexaura*, creating for them the new generic title of *Plexaurella*.

Gorgonella.—Polypary much branching; sclerenchyma very slender; calices little or not at all prominent. Milne Edwards considers this genus equivalent to *Leptogorgia;* the spicula, moreover, of *G. sarmentosa*, the only species I have yet examined, are not distinguishable from the type predominant in the last-named genus.

Verrucella.—The author just quoted regards this genus as corresponding with *Gorgonia* proper. The polypary is arborescent, the sclerenchyma moderately thick, and furnished with exceedingly prominent calices. In correlation with the above, it is a significant fact that the spicula of *Verrucella gemmacea* agree, to a certain extent, with the form characteristic of *Gorgonia verrucosa* and its allies, possessing a modification of the lagenate type (Plate XLII., Figs. 27, 28); the attenuato-fusiform is, however, not represented but replaced by a form best described as the spiked dumb-bell type (Plate XLII., Fig. 29).

Plexaura nodulifera, M. Edw. (*Gorgonia,* Lamk.), possesses spicula conforming with the last type described, and also a modification of the same, but the lagenate type is wanting.

In *Verrucella violacea*, the spicula, all of which are of a brilliant crimson, assume an entirely different form; and on a small scale they present a close resemblance to what obtains in the genus *Eunicea*, being, though small, neatly fusiform spicula bearing numerous transverse rows of symmetrically disposed tubercles (Plate XLII., Figs. 33, 34). It seems highly probable that this species may form the type of a new genus, having incorporated with it the *Gorgonia lilacina* and *sanguinolenta* of Valenciennes, these two species possessing spicula exactly harmonizing in contour with the form just alluded to.

The spicula of *V. flexuosa* agree with the *Juncella* type, to be presently described.

Ctenocella.—Polypary prolonged in the form of a straight rod, having the branches disposed in a pectinate manner on one side only.

The form and disposition of the calices in the single species, *C. pectinata*, and the character of the spicula, are so precisely similar to what obtains in *Juncella*, that it must necessarily be incorporated with that genus.

Juncella.—Polypary more or less rod-like, polyp-cells scattered. The very characteristic form of spicula invariably predominant in this genus is the mammillate or tuberculate dumb-bell type (Plate XLII., Fig. 38). This type is constant without exception, through the four species of Milne Edwards, *juncea*, *vimen*, *hystrix*, and *elongata*, *Juncella surculus* and *caliculata* of Valenciennes, and *Juncella flabellum* of Johnson.

The following species, which possess the same form of spicula, must be associated with the foregoing. They have hitherto occupied a different position in the system of classification adopted by Milne Edwards, and have been briefly alluded to *en passant* in the consecutive order in which they occur. These are, *Primnoa myura*, *Leptogorgia Boryana*, *Rhipidigorgia lacuens*, *plagalis*, and *umbraculum*, *Pterogorgia betulina*, *Verrucella flexuosa*, and *Ctenocella pectinata*.

We have now arrived at the end of that section to which I proposed to confine my present observations. The representatives of Milne Edwards' genera, *Rhipidigorgia*, *Leptogorgia*, and their allies (and under which latter designation (*Leptogorgia*) I would include all those *Gorgonaceæ* possessing essentially the short fusiform spicula predominant in the last-named genus), require more study than I have yet had leisure and opportunity to bestow upon them; and although this Leptogorgian type of spicula collates together species differing most widely in the general external form of their polyparies, there is nevertheless, in addition to that afforded by the spicula, a certain harmony pervading the character of the cœnenchyma and the form and disposition of the individual polyp-cells throughout the entire group which may possibly warrant their eventual arrangement under one generic title. In illustration of the small value of general external form for the purposes of even specific diagnosis, as applied to the "hard structures" of the *Cœlenterata*, I need only refer to *Millepora alcicornis* among the *Madrepores* or "Stony Corals," in which the amount of variation of the external contour of its corallum is simply perplexing; the most striking examples of these, taken separately, might be almost supposed to represent distinct genera, but the existence of intermediate conditions intimately uniting the whole series unquestionably substantiates their specific identity.

The facts which have been eliminated in the foregoing remarks will, I think, suffice to demonstrate beyond doubt what a highly important element the Calcareous Spicula represent in our appreciation of the generic characters of the *Gorgonidæ*. The study of the group from this point of view must, however, be considered quite in its infancy; but the time has arrived when zoologists must no longer be content with the characters afforded by general contour or by the examination of the dried polyparies only. Not only is it necessary that the spicula alone should again be studied; our information respecting the variations in form of the polyp-animals themselves is as yet of the most meagre description; and until we have learnt to appreciate these characters by the examination of the animals preserved in spirit, or, what is more important still, alive in their native element, we can scarcely expect to arrive at a just estimation of their true zoological affinities.

Further particulars respecting the specific variations of the spicula, the position the different forms occupy in relation to the common polypary, and the general law of affinity which undoubtedly pervades the whole series, must necessarily form the subject of a future communication.

In conclusion, I must not neglect to testify to the good work our trans-Atlantic cousins are achieving in this direction by fitting out expeditions, for the main purpose of exploring and arriving at a better knowledge of the representatives of the Marine fauna on the other side of the Atlantic;* an example, which it is a pleasure to be able to add, the British Government has at length recognized the high importance of following; and in fact if England is (and may such be her ever happy destiny) to remain

* The names of Prof. A. E. Verrill and Count Pourtales are particularly worthy of notice for having contributed so richly to our knowledge of the *Cœlenterata*. Many new genera and species of *Gorgonaceæ* have been described by them; but want of space necessarily obliges me to postpone entering on the present occasion into the results of their investigations.

"Mistress of the Seas," it behoves her not to allow her *prestige* associated with the briny element to remain simply superficial. There are laurels to be reaped, only by the hand of Science, in the vast abysses of the ocean, which shall add a lustre to her diadem that shall remain untarnished till time and space shall be no more.

VI.—*On Pollen; considered as an Aid in the Differentiation of Species.* By Charles Bailey, Esq.

Having recently examined the pollen of several thousand species of plants, I am led to think that the characters presented by these grains might prove useful as a means of differentiation in allied species; my researches, however, have not been sufficiently extensive to form any positive conclusions, but as leisure permits I hope to prosecute the subject further. In the meanwhile, the following notes are thrown out as indications of some of the more noticeable distinctions to be drawn from a careful comparison of these organs, and they may serve to draw the attention of others to the matter.

There are four points, in one or other of which pollen-grains of plants belonging to the same genus may be found to differ from each other, *viz.* form, markings, dimensions, and colour.

1. *Form.*—It has long been noticed that certain types of pollen are characteristic of the natural order to which the plants which produce them belong, as, for instance, the peculiar pitted polyhedral pollen of the *Caryophyllaceæ,* the spherical spiny pollen of the *Malvaceæ*, the large triangular pollen of the *Onagraceæ*, the peculiar pollen of the *Coniferæ,* or the elliptical pollen of the *Liliaceæ* and other monocotyledonous orders; in fact, most orders possess a type sufficiently marked to be characteristic of each. This statement, however, must be accepted with limitations; the *Compositæ*, for instance, have three or more well-marked types, represented by the beautifully sculptured pollen of the Chicory, the minute oval spiny pollen of the Asters, Calendulas, Cacalias, &c., and another form wholly destitute of spines, as in the *Centaurea scabiosa.* There are, besides, other natural orders where similar variety occurs.

But differences of form are met with in plants of the same genus, by which the one species or the other is readily marked off by its pollen; thus the pollen-grain of *Anemone sulphurea* is roundish, but that of *Anemone montana* is elliptic; the pollen of *Aronicum Doronicum* is much more elongate than that of *A. scorpioides;* and while the grains of *Ranunculus philonotis* are round and yellow, those of *R. platanifolius* are elliptic, white and smaller.

2. *Markings.*—Here again there is endless diversity, and a boundless field lies open for the researches of tired-out dot and line hunters of diatom-valves. A few instances only of the more striking differences can be given here.

The pollen of the *Geraniaceæ* and *Campanulaceæ* is for the most part globular; but while some of the grains are quite smooth, others are covered with spines; thus the pollen of *Campanula media* has a number of short spines sparsely scattered over the surface of the grain, but *C. rapunculoïdes* is wholly destitute of them. In other plants these spines are replaced by tubercles, and both spines and tubercles vary greatly in length and number; for example, in *Valeriana tuberosa* the spines are only half the length of those on the pollen of *V. montana*, the grains being also slightly smaller. The pollen of the *Liliaceæ* is oftened covered with a more or less prominent reticulation, which is subject to much variation; compare, for example, the coarse network which invests the pollen of *Lilium croceum* with the finer reticulation of *L. canadense*, the grains of the latter species being much more globose and smaller.

3. *Dimensions.*—Some instances of the differences observable in the size of pollen-grains have already been published by Professor Gulliver, whose measurements of the pollen of various species of *Ranunculus* show the help that may be derived from this character; *R. arvensis* is nearly twice the size of *R. hirsutus*, their dimensions being respectively $\frac{1}{470}$th and $\frac{1}{888}$th of an inch.

I have not had the time to make similar careful measurements with the micrometer, but I have seen sufficient to be satisfied that while there is considerable variation in dimensions between the pollen of one species and that of another, they are tolerably constant in size in the same species.

For some noticeable differences compare the smaller pollen of *Epilobium brachycarpum* with the larger pollen of *E. Fleischeri*, or that of *Senecio gallicus* with *S. incanus*, the spines on the latter species being also much coarser. Again, the pollen of *Silene acaulis* is but half the size of that of *S. alpina*, the latter having some beautiful markings in addition; the pollen-grains of this genus differ from the usual caryophyllaceous type in not having the pits or depressions common in the order, so that the grains become spherical rather than polyhedral.

4. *Colour.*—This is not so reliable a character for differentiation as the others noticed, since species differ amongst each other according to the soil, &c., of the place where they have grown. I remember gathering some years ago, near Ashbourne, Derbyshire, a variety of *Stellaria Holostea* having a dark purple pollen instead of the ordinary pale yellow. An example or two under this head will suffice.

The pollen of *Ajuga genevensis* is yellow, but that of *A. pyramidalis* is usually white; again, while the grains of *Ornithogalum umbellatum* are large and yellow, those of *O. nutans* are small and white.

Some objection may be raised to any reliance being placed upon the dry shrivelled-up grains of herbaria specimens—such specimens being in most cases the only ones obtainable for purposes of investigation; but the structure of pollen is such as to bring into greater prominence the pores, folds, valves, and other markings which are met with on their surface after the grains have collapsed by the discharge of their contents.

In regard to the mounting of these objects for the microscope, they show to the best advantage when put up perfectly dry; the cells should be sufficiently shallow to admit of no more than a single layer, and at the same time deep enough to permit the grains to move about. If pollen is mounted soon after it has been discharged from the fresh anthers, the fovilla is apt to condense on the covering glass, and the slide soon becomes useless. The stamens taken from an unopened flower-bud furnish the best and cleanest pollen, and these should be selected in preference to those taken from the fully-developed flower.

Canada balsam, glycerine, and other media are occasionally helpful in making out structure; thus the pores of *Campanula rotundifolia*, *Phyteuma Halleri*, and other allied species, are made much more distinct when mounted in balsam.—*Paper read before the Literary and Philosophical Society of Manchester.*

VII.—*On Professor Listing's* recent Optical Improvements in the Microscope.* By Dr. H. Hagen.

In all microscopes the dioptric arrangement is now analogous to the astronomic spy-glass; they have but one real image, from which the virtual image is formed and brought to the eye of the observer.

Professor Listing proposes to have two real images, and in this way to form three successive augmentations instead of two, as before. It is well known that by a prolongation of the draw-tube, or by increasing the distance between the objective and the eye-piece, the image becomes successively greater, but the definition and penetration is by no means better. Professor Listing has made some experiments, and states that with an eye-piece of his

* See also 'Nachr. d. kgl. Gesell. der Wissensch.,' 1869, No. 1, and Poggendorff's 'Annalen,' 1869, T. xvi., p. 467.

construction (a double eye-piece with four lenses, similar to those of the terrestrial spy-glasses) the magnifying power of the instrument, and also to nearly the same degree the penetration, is raised, by a tube of 430^{mm}, 20, 28, 55, 97, and 137 per cent. (the latter, of course, with diminution of the field), more than the same objective (Hartnack's, No. 7) and eye-piece (No. 3) with a tube 200^{mm} in length. The object was *Pleurosigma angulatum*, and Professor Listing assures us that the latent power of the objective is developed by this means in an astonishing manner. He also remarked that the so-called Erectors have long been used, but always with a low power and a short tube. The most advantageous form for the eye-piece would be, for the two superior glasses, achromatic lenses from 15 to 20^{mm} in diameter, and with a diaphragm between, having an aperture of from 8 to 9^{mm}. For the two inferior lenses, a common Huyghen's eye-piece would be the best. Such a combined eye-piece, with a tube 420^{mm} long, would raise the power of the instrument 97 per cent. The use of an achromatic condenser adapted for oblique illumination is necessary for high powers. The experiment was only successfully made with the best objectives of English artists, or with the excellent new Hartnack objectives.

According to his calculation, an objective of 1^{mm} distance will give the first real image at a distance of 200^{mm} from the second chief point of the objective; and combined with an eye-piece in Listing's manner, having a power of 25 diameters by itself, and a tube 450^{mm} long, the magnifying power of the whole instrument would be 5000 diameters.

In the common arrangement of the microscope, the dioptric cardinal points are in the same order as in a cancave lens, and the focal distance of the whole microscope (not of the objective) would be equal to $-\cdot 5^{mm}$, with a magnifying power of 400 diameters for a visual distance of 200^{mm}.

In the Listing instrument the order of the cardinal points would be inverted and analogous to a convex lens, with a focal distance of the whole microscope equal to $+\cdot 04^{mm}$, with a magnifying power of 5000 diameters. In the first case the objective would have a focal distance of 3^{mm}; in the last of 1^{mm}. The difference between the two chief points of the whole microscope is in both cases nearly equal to the whole length of the tube. In the last arrangement the whole microscope is analogous to a convex lens with very short focal distance.

In a second paper Professor Listing gives further facts concerning this arrangement. An objective with a focal distance of 1^{mm} has the first image 201^{mm} distant from the second chief point. The first magnifying is $= 200$. The middle eye-piece of two achromatic lenses with 25^{mm} focal distance, and 15^{mm}

distance from each other, gives a focal distance of 18^{mm}, and so the second magnifying is = 9 This apparatus having the objective and middle eye-piece combined with the five eye-pieces of Hartnack (magnifying from $\frac{3}{10}$ths and $\frac{8}{10}$ths to 11 diameters), gives a total power of from 6840 to 19,800 diameters, with a tube of 440^{mm}.

Professor Listing advises that the lenses of the eye-piece should be made of 15^{mm} diameter, and with a correction for their distance. For the middle eye-piece, perhaps, lenses of quartz combined with a lower (1·61 to 1·59) flint glass should be used. In another place he gives a different construction for the middle eye-piece, analogous to an objective of two glasses, but with greater dimensions, and calculates the magnifying power of this to be from 22,000 to as much as 25,600 diameters.

Professor Listing observes that only the penetrating power would be raised by this method of construction, but that to a very considerable degree.—*A paper read before the Microscopical Section of the Boston Society of Natural Science*, November 10, 1869.

PROGRESS OF MICROSCOPICAL SCIENCE.

The Cause of Variegation in the Leaves of Plants.—Practical botanists are well aware of two things: (1) that a rage now exists for plants the leaves of which are blanched in parts; and (2) that whatever the nature of this blanching, which sometimes appears spontaneously, any plant may be made variegated by inoculating into it the sap of one which is variegated already by means of engraftation. But the cause of this phenomenon has been sought by M. Edouard Morren who, in a most interesting paper on the whole subject, recently read before the Belgian Academy, tries to explain it. Dr. Morren recites the experiments of others, and he seems to imply that the affection, for such there is reason to regard it, is the result of the presence of minute corpuscles which have no green colour like the ordinary corpuscles. The etiolated parts, he says, are not altered by carbonic anhydride(?), and they enclose "imperfect granulations deprived of green colouring matter." Dr. Morren refers to the recent able experiments of our countryman, Dr. Maxwell T. Masters, on *Jasminium officinale*, and his paper is of interest because, as it seems to us, it opens up a field in which every microscopist may do some good work.—Vide *L'Institut*, January 19.

The Movement of the Chlorophyll Corpuscles.—At the meeting of the French Academy of Sciences on the 17th of January, a note was presented from M. Rose relative to M. Prillieux's last researches on the influence of light on plants. The author has found that the light does not affect each individual corpuscle so as to cause it to move, but operates on the material surrounding a number of corpuscles, and by influencing it causes the corpuscles to move.—Vide *Comptes Rendus*, January 17.

The Constitution of the Ovum in Sacculinæ.—M. Balbiani replies to M. Ed. Van Beneden on this point in a paper read before the French Academy. He considers that he has proved that the small clear elevation placed on one of the points of the surface of the egg of the Sacculinæ is not the cicatricule as supposed by M. Gerbe, but is really a small rudimentary ovule, adherent to the matured one, and which is subsequently detached from it. "M. Ed. Van Beneden," says M. Balbiani, "thinks that after its separation the minute ovule remains in the interior of the reproductive organ to give birth to two daughter-cells, which become adherent to each other, and one of which, in its turn, becomes an egg. According to his view, a single cell would by successive sub-divisions give rise, without ceasing, to new ova. This explanation is not only improbable but is actually in contradiction with the direct observation of facts. According to my observations upon the ovary in the fresh state on specimens hardened in spirits of wine, and from which sections had been made in various directions, this is how the thing really takes place:—On a point of one of the ramifications of the ovary a small cell appears at first by a process of budding. In growing, this cell pushes before it the external epithelial envelope of the ovary, which thus becomes the wall of the ovigerous follicle. The latter is pediculated, and the small cell within it soon forms by division two new cells like the parent one. This division is further pursued once or twice on each of these, and it is one of the daughter-cells of the last generation which becomes the 'viable' egg. In the ovigerous follicles one sees ovules still in the rudimentary state under the form of a small cellular group situated in the inferior part of the follicle below the ovum in course of its development. I can do no better than compare these bodies to the *vitelligenous* cells of insects; both appear to me, in fact, to be nothing less than abortive eggs, with this distinction always, that in insects the cells maintain an organic union with each other and the egg in course of development, whilst in the *Sacculinæ* they are either free or have a slight connection with the latter. I do not believe either that after the deposition of the mature ovum the little 'polar cell' remains in the ovary to become the starting-point of a new ovum, as M. Ed. Van Beneden describes. It is easy to assure oneself, by means of hardened preparations, that the cell has no relation save with the egg to which it is adherent, and that consequently it must be carried by it in its passage from the follicle, and must fall with it into the ovarian sac." M. Balbiani's paper, which is of much interest to comparative anatomists, then deals with the general question of the primordial division of the ovum in *Sacculinæ* as pointed out in the vertebrates by Pflüger, Kölliker, and others, and also with the points in relation to the second organic element (in addition to the vesicle of Purkinje, which he admits the existence of in *Sacculinæ*). —*Comptes Rendus*, December 27, 1869.

The Afferent Canals in Clionia celata (*Grant*).—M. Leon Vaillant, in some recent dredging excursions, has had an opportunity of studying this curious penetrating sponge while alive and upon the oyster-shell. His observations have led him to different conclusions from those established by Professor Grant. He states that in *Clionia celata*, while the papillæ in the wide perforations are, as has long since been shown, the oscula or efferent orifices of the water current which pervade the parenchyma, the papillæ of the second form are really the pores of distinct afferent currents.—*Paper read before French Academy, January* 3, 1870.

Nitrate of Silver as an aid in Microscopic Investigations.—M. Grandry has communicated to the 'Centralblatt' the results of his observations on the action of nitrate of silver on nervous tissue. He used the tissue obtained from the frog and rabbit for his experiments, and placed portions both from the centres and the nerves in a one-fourth per cent. solution, macerating them for five days in the dark, and then exposing them for three days to bright light. If the surface of the cord thus treated be carefully teazed out with needles, the axis-cylinders are found to exhibit a very regular and sharply defined transverse striation—clear, unstained striæ alternating with deeply tinted ones. The breadth of the dark striæ varies from one to five thousandths of a millimètre; that of the clear, from one to three thousandths. In addition to the transverse striation, the axis-cylinder also exhibits well-marked longitudinal striation, so that it presents a singularly close, though probably only superficial, analogy to a muscular fibre. Examination by polarized light, however, does not furnish any evidence of the existence of a doubly refractile substance. M. Grandry observed a similar transverse striation in the bodies of, and in the processes given off from, ganglion cells, especially in those of the anterior horn of the cervical portion of the spinal cord.—*The Lancet*, January 15.

Fossil Bryozoa.—The study of the fossil Bryozoa is a fertile field for microscopists, and is being pursued more abroad than in England. A memoir by an Italian, Signor Manzoni, was recently read before the Vienna Academy (Dec. 16), on the Fossil Bryozoa of Italy. The author went very fully into the subject, and described no less than twenty-one species of Lepralia, and gave four plates illustrative of his observations. Only six of the species are already known: *L. scripta*, *pteropora*, and *tetragona*, Rss.; *linearis*, Hassall; *ansata*, Johnst., and *ciliata*, Pall.; the remaining fifteen are quite new. The greater number of the species (twelve) are from the Middle Miocene of Turin; four are from the Middle Pliocene of Castellarquata; and the remaining five are from the Upper Pliocene of Reggio in Calabria.

The Terminations of the Biliary Ducts.—This question, which has been solved in opposite ways by Drs. Beale and Handfield Jones, has recently been taken up in America. A paper on the subject appeared lately in the 'New Orleans Journal of Medicine,' and is thus abstracted by the 'Lancet' (January 22), which has lately from time to time published some very valuable *résumés* of foreign histological papers. The writer in the 'Lancet,' whom we think we could name, thinks that the author of the paper in question, Dr. H. D. Schmidt, satisfactorily makes out his claim to being the discoverer of the termination of the biliary ducts in biliary capillaries, which is now very generally admitted. By a series of unfortunate circumstances, amongst which the fire that occurred in the Smithsonian Institute, the civil war, and Dr. Schmidt's ill-health, were the most important, the observations made in 1859 have only now been published. Dr. Schmidt's observations seem to be essentially similar to those that have of late years been advanced by Budge, M'Gillavry, Chrzonsczczewsky, and Eberth, and are to the effect that two capillary networks exist in the lobule of the liver: one, commencing at the periphery of the lobule from the smallest branches of the portal vein and hepatic artery, and ending at the centre in those of the hepatic vein, serves for the circulation of the blood; the other, commencing independently in the centre of the lobule, near the interlobular vein, and ending in the smallest branches of the hepatic ducts, is most probably destined for the transport of the secretion of the gland. The cells lie within the meshes of the two networks; but, as it appears, are held and adherent more to the network for the secretion. Dr. Schmidt agrees with M. Guillot in believing that a natural communication exists between the biliary ducts and the deep-seated lymphatics of the liver. Both Kiernan and Mascagni noticed that injections thrown into the ducts returned by the absorbents, and the former observer stated that bile is frequently propelled into the absorbents on injecting the duct; and it is known that in some diseases of the liver the hepatic lymphatics are found to be distended with bile.

Sponges or Worms.—In a paper read before the Montreal Natural History Society, on the 29th of November, "On the Genus Scolithus and some Allied Fossils." Mr. Billings attempted to prove that the well-known fossil *Histioderma Hibernicum* from Bray in Wicklow are really not the casts of an annelid, but are, as their structure seemed to show, veritable sponges.

A Microscope and Camera combined.—Those who care for the *multum-in-parvo* class of apparatus will do well to read the description ('British Journal of Photography,' January) of a new instrument invented by MM. Borie and de Tournemine, and exhibited at a meeting of the French Photographic Society. The description of the instrument is too long for our pages. But we may state that, according to the inventor, the apparatus may be used as the following separate instruments:—A solar microscope, a photographic solar microscope, a compound microscope, a photographic apparatus, an enlarging apparatus for negatives, a terrestrial telescope, a telescopic photographic apparatus, an enlarging apparatus direct upon paper, and a photographic ophthalmoscope.

NOTES AND MEMORANDA.

Soirée of the Old Change Microscopical Society.—We learn from the secretary, Mr. S. Helm, that the fourth annual soirée of this Society will take place at the City Terminus Hotel, on the 14th inst. Gentlemen desirous of exhibiting objects at the soirée should communicate with the secretary without delay.

Microscopy in Dublin.—The following quotation from 'The Medical Press Circular' of the 19th of January, needs no comment from us; its force will be fully apparent to our readers:—"Dr. John Barker read an interesting paper 'On Microscopic Illumination' at a meeting of the Royal Irish Academy on the 10th inst. Dr. Barker truly describes the present defective manner of viewing microscopic objects, by saying that ordinarily on looking into a microscope we feel disposed to shrink from the sudden glare of light which strikes on the eye from the field of vision, which is flooded with intense light; the pupil contracts, and at first we see nothing at all; presently a something semi-transparent is rendered visible by the relative opacity and transparency of its parts, and by the shadows they cast on the retina and on other portions of the object. Now, all these effects will not show us its true structure, but will rather contribute to a false impression of what is under examination. From such considerations as these, Dr. Barker concludes that axial illumination, in which a large portion of the central rays of light are stopped off, is the only one which ought to be admitted in microscopic research—a conclusion already arrived at by most of our best microscopists; but all have hitherto experienced a great difficulty in obtaining sufficient light, and of economizing the oblique rays (those most valuable), which are generally reflected to a large extent, and even dispersed at the under surface of the slide on which the object is placed. To obviate these difficulties, Dr. Barker makes use of the immersion plan, by placing between the slide and illuminator a film of water or oil; this gets rid of all, or almost all, the defects of former modes of illumination. This film acts as a medium, permitting rays of light, without sensible deviation or dispersion, to reach the object, and also allows all stage movements to be freely used. The light obtained in the manner indicated is almost purely achromatic, and is sufficiently oblique to give a black-ground illumination with an eighth of an inch object-glass (immersion), and will show clearly the dotted structure of the lines on the *Pleurosigma formosum* with a quarter-inch object-glass, and with a two-thirds used binocularly the surface and interior of certain classes of objects are shown in a manner hitherto not seen. Dr. Barker's first experiments were with a flat-topped paraboloid, and, after the meeting of the Academy broke up, the members had an opportunity of viewing with it a specimen of the *Conocholus volvox* (a truly beautiful object)."

The Quekett Club's Journal.—We are informed that the committee of the Quekett Club have re-considered their recent determination. It is now proposed to issue the 'Journal' of the club as heretofore.

Dr. Woodward's Paper.—The figure omitted in the publication of this paper will be supplied, printed on a separate "slip," in our next. Readers will then have an opportunity of inserting it in the proper place in their volumes.

CORRESPONDENCE.

Nobert's Test-Lines.

To the Editor of the 'Monthly Microscopical Journal.'

148, Cheapside, E.C., *January* 12, 1870.

Sir,—In p. 283 of the Journal for November last, the reporter of the discussion on Dr. Woodward's paper appears to have quite misunderstood my remarks. I did not say that Messrs. Powell and Lealand had "ruled a test-object with 100 lines in $\frac{1}{1000}$," which is a mistake. I expressed a doubt whether the lines on Nobert's test-plate could be clearly defined beyond the 16th group. I added that with Powell and Lealand's new method of oblique illumination the lines on the *Amphipleura pellucida* and *acus* could be clearly shown with their immersion $\frac{1}{8}$th, $\frac{1}{12}$th, and $\frac{1}{16}$th, which also give a beautiful definition of the Podura scales. Mr. Lealand has succeeded in counting the *Amphipleura* lines, and finds them 100 in $\frac{1}{1000}$th of an inch.

Ellis G. Lobb.

Collins' Dissecting Microscope.

To the Editor of the 'Monthly Microscopical Journal.'

January 13, 1870.

Dear Sir,—In reply to the letter of Dr. Swintard, of the New York College of Veterinary Surgeons, I should be glad to explain that if I adopted any plan (invention I did not presume to call it) of Dr. Busteed's it was quite unknown to me; but there is one part of my arrangement that I find much appreciated, and is, I think, novel.

If the engraving is examined it will be seen that the arm is in two portions; the lower half with the objectives is fixed, and the upper half carrying the body turns upon a centre, so that it can be instantly converted from a single microscope to a compound, or *vice versâ*. It is also fitted with my new double nose-piece, so that the changes of power can be most easily and quickly effected.

Before Dr. Swintard's letter appeared, I was engaged in carrying out a suggestion of Mr. Westell's; this is now nearly completed, and will greatly add to its value as a dissecting microscope, and at the same time remove it from any apparent similarity to that made by Mr. Grunow.

I am, sir, your obedient servant,

Chas. Collins.

PROCEEDINGS OF SOCIETIES.*

Royal Microscopical Society.

King's College, *January* 12, 1870.

The Rev. J. B. Reade, M.A., F.R.S., President, in the chair.

The minutes of the previous meeting were read and confirmed.

A list of donations to the Society was read, and a vote of thanks given to the respective donors.

Mr. Slack announced that Messrs. Gould and Porter had sent for exhibition a specimen of their small cheap education microscope; and that the Rev. T. H. Browne, of High Wycombe, had presented to the Society a box containing one dozen slides of carefully prepared sections of bone.

A vote of thanks was passed to Mr. Browne.

Mr. Slack also said he had been requested to state that at the next meeting of the Society (which would be the annual meeting) a proposition would be brought forward to discontinue the practice of providing refreshments after the ordinary meetings, as it was found that less than half the Fellows who attended availed themselves of the provision made, and that in lieu thereof a friendly conversazione should be held. By this means a saving of some 16*l.* to 20*l.* per annum would be effected, which might be advantageously appropriated to the purchase of books and apparatus. The Council had no wish to influence the decision of the Fellows, but thought it worthy of their consideration.

The President proposed that M. Mouchet, of Rochefort-sur-Mer, should be elected an Honorary Fellow of the Society. M. Mouchet was an ardent microscopist, and would feel much pleasure in being more intimately connected with the Society. He had obtained some distinction for inventions in relation to microscopical apparatus, for one of which (a method of cutting wood for microscopic examination) he had received from the French emperor at the late Exhibition a gold medal of honour. He had also devised a finder of more extended application than Maltwood's, for not only could the objects be found, but also accurately measured. The President then read a short communication from M. Mouchet referring to his machine for cutting thin sections of wood.

The ballot was then ordered to be taken for the election of M. Mouchet.

Mr. J. Beck was happy to add his testimony to M. Mouchet's character as a diligent student of microscopy, and very cordially supported the proposition of the President.

The list of Fellows who would be proposed as officers of the Society at the annual meeting in February was then read.

* Secretaries of Societies will greatly oblige us by writing their reports legibly —especially by printing the technical terms thus: H y d r a—and by "underlining" words, such as specific names, which must be printed in italics. They will thus ensure accuracy and enhance the value of their proceedings.—Ed. M. M. J.

It was proposed and seconded, and unanimously agreed to, that Messrs. Suffolk and Becket be requested to act as auditors for the year.

The President then requested Mr. J. Browning, F.R.A.S., to read his paper "On a Method of Measuring the Position of Absorption Bands with a Micro-spectroscope."

Mr. Ingpen inquired whether Mr. Browning did not think that two lines crossing at an acute angle, as in his (Mr. Browning's) star-spectroscope, would be preferable to a single vertical line; as he thought the position of a band or line in the spectrum could be more accurately measured if caused to bisect an angle than if covered by a bright line.

Mr. Browning thanked Mr. Ingpen for his suggestion, and he thought much advantage would arise from its adoption.

Mr. Brooke said it appeared to him that Mr. Browning's invention was a very valuable one, as it rendered micrometric measurement very simple. The use of a micrometer with a bright image instead of a dark image would be very advantageous; for whereas on a slightly illuminated field the dark image is invisible, by substituting the bright line for the dark line every purpose is answered.

Dr. Lawson said he felt much indebted to Mr. Browning for his invention. He had worked for some time past with the interference scale of Mr. Sorby, but had met with the difficulties which Mr. Browning had enumerated, but he had always been unable to calculate easily the number of the bands lying between the 1st and 12th. The invention just described would make such an operation easy for the future.

The President, in presenting the thanks of the meeting to Mr. Browning, said that the improvements made by him in the construction of the micro-spectroscope were felt by all to be very valuable. It appeared as if the wonders capable of being revealed by this instrument were only beginning to dawn upon those who used it.

Mr. Hogg then gave a brief account of Mr. Alfred Sanders' paper "On an Undescribed Stage of Development of *Tetrarhyncus corollatus*." The thanks of the meeting were then given to Mr. Sanders.

The President called upon Mr. W. S. Kent to read his paper "On the Calcareous Spicula of the *Gorgonaceæ*."

Mr. Stewart inquired of Mr. Kent whether he had come to any conclusion as to the mode of the formation of the spicules he had described. There were instances of agreement in form, but of difference in construction; as in those cases where there was an intermixture of horny and calcareous matter. His own opinion was that this compound structure was due to the molecular coalescence of carbonate of lime deposited in the colloid matter of the animal, thereby modifying the physical forces always operating in the animal.

Mr. Kent replied that he had not paid sufficient attention to this part of the subject to be able to arrive at any conclusion thereon.

Mr. Stewart again inquired how Mr. Kent accounted for the fact that in the flask-shaped spicules the bases projected towards the outside, and the neck was directed towards the axis of the gorgonia? It was in his opinion important to consider the relative position of the spicules, not only to each other, but also to the animal itself.

Mr. Kent replied, and the President proposed a vote of thanks to Mr. Kent, observing at the same time how the paper illustrated the well-known truth that nature is constant in her law, but infinite in her modifications. The endless variety in the leaves of trees is hardly more striking than the varied structure of the spicula of the Gorgoniæ, which clearly are characteristic of genera and species. To arrive at any law of formation would involve very difficult but interesting inquiries.

The meeting was then adjourned until the 9th of February, which will be the anniversary. The officers for the ensuing year will be elected, and the President will deliver an address.

Donations to the Library and Cabinet from December 8th, 1869, to January 12th, 1870:—

	From
Land and Water. Weekly	*Editor.*
Society of Arts Journal. Weekly	*Society.*
Scientific Opinion. Weekly	*Editor.*
Nature. Weekly	*Editor.*
The Student	*Publisher.*
Journal of the Linnean Society	*Society.*
Annual Report of the Brighton and Sussex Natural History Society	*Thos. W. Wonfor, Esq.*
Certain Butterfly Scales characteristic of Sex. By Thos. W. Wonfor. 2 Parts	*Author.*
The Chemical News. 4 Parts	*W. T. Suffolk, Esq.*
The Canadian Journal.	
Popular Science Review. No. 34	*Publisher.*
Journal of the Quekett Club	*Club.*
A Photo-lithograph of Diatoms	*Rev. Thos. Wiltshire.*
One Dozen Slides of Bone Sections	*Rev. Thos. H. Browne.*

Walter Tebbitt, Esq., was elected a Fellow and M. Mouchet an Honorary Fellow of the Society.

WALTER W. REEVES,
Assist.-Secretary, &c.

LITERARY AND PHILOSOPHICAL SOCIETY OF MANCHESTER.

Microscopical and Natural History Section.

December 6th, 1869.—John Watson, Esq., President of the Section, in the chair.

Mr. W. Boyd Dawkins, M.A., F.R.S., was elected a member of the Section.

Mr. Charles Bailey read a paper "On Pollen; considered as an Aid in the Differentiation of Species." [This paper will be found among our articles.]

Mr. J. B. Dancer, F.R.A.S., read a short paper on some of the new Hydro-Carbon compounds from which he had obtained very beautiful polarizing objects for the microscope. These were exhibited to the members, and a more detailed account promised when the experiments are complete.

Manchester Microscopical Section of the Lower Mosley Street Schools.—Natural History Society.*

A conversazione was held on Monday evening, January 10th, 1870, about 120 being present. The members brought their microscopes, and other objects relative to the science of microscopy were exhibited. J. Barrow, Esq., President, in the chair.

The President stated that the object of the meeting was to create a taste for the study of microscopy, to show the work of the members, and to give some idea of the pleasure the microscopist enjoys.

The President gave a short address "On the Life History of Ferns," showing the value the microscope had been in defining their organization.

Mr. Aylward exhibited with Reade's prism various diatoms; two small aquariums containing animalculæ; and a number of trays of foraminifera, &c.

Mr. Armstrong, a series of insects mounted whole; a number of slides of various parts of insects; some human anatomical preparations; and a number of micro-photographs.

Mr. Hope, a number of ferns and miscellaneous slides.

Mr. Chaffers, sections of mollusca.

Mr. Hyde, vegetable cuticles.

Mr. Jackson, a series of seeds, and a number of ferns showing fructification.

Mr. H. C. Armstrong, a number of corallines, scales, foraminifera, &c.

Mr. Armstrong exhibited, with the gas microscope, a number of slides of diatoms, insects, parasites, &c.; also, by the oxy-hydrogen lantern, some micro-photographs taken on Dr. Maddox's principle.

This was exceedingly successful, and added considerably to the interest of the meeting.

The President read the list of papers for the present quarter.

Reading Microscopical Society.†

December 21st, 1869.—Captain Lang (the President) presided, and after the usual business

Mr. Vines read a paper "On Urinary Deposits." In it he referred to the valuable aid of the microscope in physiological research; and after giving a detailed account of the structure of the kidney and its functions, proceeded to describe the characters of healthy urine, and the microscopic appearances of urea, sugar, and the various salts met with in deposits. He also dwelt upon the means of diagnosis afforded by casts of uriniferous tubes and the cells they entangled. His paper was illustrated by a diagram and examples of deposits.

* Report supplied by Mr. W. Jackson.

† Report furnished by Mr. B. J. Austin.

Acting upon a resolution passed at the November meeting, whereby papers upon Natural History subjects not exclusively connected with the microscope were made admissible, Dr. Moses gave interesting particulars of the spur-winged goose (*Anser Gambensis*), of which a specimen had recently been shot in Hampshire; and Mr. F. A. Bulley read a short paper "On a Remarkable Case of Animal Malformation," in which he described a preparation placed upon the table. This consisted of a pig which had lived four hours, and at the time of its birth was furnished with a trunk about two inches long formed of flexible rings and ending in a prehensile appendage, with tubular passages exactly like the trunk of the elephant. Its ears and epidermis were like those of the elephant, while the eyes were in an unusual position.

Captain Lang exhibited *Petrobius maritimus*, and Mr. Tatem showed various insect mounts.

January 18th, 1870.—Captain Lang presided, and, after the transaction of business, the secretary read a paper "On the Structure and Affinities of Lycopods;" embracing an account of the microscopic structure of the various tissues and organs, and a comparison of the club-mosses generally, with conifers, ferns, mosses, and selaginellæ. The paper was illustrated by specimens and mounts.

Captain Lang showed mounted specimens of two different species of Acari found on house-fly, also of *Coleochæte scutata*, and *Chætophora tuberculosa*.

Mr. Tatem exhibited *Trinoton conspurcatum* and *Lipeurus jejunus*, parasites from the goose; *Hæmatopinus acanthopus*, from the field-mouse; *Nirmus argulus* (before and after moult) and *Colpocephalum subæquale*, from the rook; the dog-tick, *Ixodes plumbæus;* and the sheep-tick, *Hippobosca ovina*.

Mr. Simpson exhibited live larvæ of the dog-flea.

Brighton and Sussex Natural History Society.

January 13th, 1870.—The President, Mr. T. H. Hennah, in the chair.—Mr. Wonfor announced the receipt of a copy of a paper from Mr. C. Roper "On the Decapod Crustacea obtained at Eastbourne," and read by that gentleman before the Eastbourne Natural History Society.

Mr. J. E. Mayall communicated a note on the discovery of copper in common coal gas, generated, he believed, from the pyrites contained in the coal. Mr. J. E. Mayall read a very interesting paper "On Volcanic Theories."

Bristol Microscopical Society.*

Wednesday, January 19th, 1870. Mr. W. J. Fedden, President, in the chair.—The minutes of the last meeting having been read and confirmed, it was announced that Mr. Roper had presented to the Society a copy of his book 'A Catalogue of Microscopical Works.'

* Report supplied by Mr. T. G. Ponton.

A unanimous vote of thanks was accorded to Mr. Roper for his donation, and he was proposed as an honorary member of the Society, to be balloted for at the next meeting.

Some discussion then ensued on the advisability of the Society's holding a public soirée. There was a considerable diversity of opinion, and the matter was finally referred to the Standing Committee.

Mr. Tibbits then read a paper "On Mounting Animal Tissues," which he illustrated by a number of beautiful preparations of brain and spinal cord made by himself.

Tunbridge Wells Microscopical Society.*

The first meeting of this Society was held at Dr. Milner Barry's house on the 4th inst., Dr. Deakin, President, in the chair.—A variety of most interesting objects were exhibited, amongst them some of the very earliest micro-photographs taken by Mr. Delves,—the circulation in Chara; sections of wood, &c. For the future each monthly meeting will be devoted to the consideration of some special subject. The Anatomy of Lichens will be discussed at the next meeting.

Birmingham Natural History and Microscopical Society.

The meetings were resumed on the 11th ultimo, when Mr. S. Allport exhibited and described a fine collection of foraminifera from the West Indian and Mediterranean Seas, obtained by shaking sponges brought from those regions over water, skimming off the shells which float while the particles of sand sink to the bottom, and mounting the specimens thus obtained in Canada balsam, after preliminary treatment with turpentine and exhaustion of air from the chambers. Special interest attaches to these organisms at the present time by reason of the attention which has lately been directed to them, in connection with the subject of deep-sea soundings, as the great chalk-forming agents of the world. Mr. Allport further referred to certain passages in systematic works on Foraminifera, with a view to prove that in this, as in other branches of natural history, varieties are too often unjustifiably elevated to the rank of species. The specimens exhibited in illustration of the subject included representatives of the genera Peneroplis, Spirolina, Orbiculina, Orbitolites, Polystomella, and Planorbulina. The Rev. H. W. Crosskey also contributed *Globigerina bulloides* from 2000-fathom soundings in the Atlantic, and foraminifera from chalk; and in connection with these made some interesting remarks on points of geology suggested by Dr. Carpenter's recent lectures. The speaker observed that modern geologists would find themselves compelled to depart from the strict and arbitrary rules by which they had hitherto separated different epochs and formations, the tendency of progressive discovery being to show that these extend into or overlap each other so that no harsh line of demarcation can be

* From the Secretary, the Rev. B. Whitelock.

drawn. He also alluded to the difficulty with which geologists have hitherto had to contend in explaining the great break in the system between the Cretaceous and Tertiary periods, which recent discovery has in a great measure enabled us to do. Among general specimens exhibited were the shells *Bythinia tentaculata* type, var. *ventricosa*, brown and white; and var. *albida*, all from Alum Rock, the last being a new variety, found by Mr. Lloyd, and named last month by Mr. Jeffries; also, *Sphærium corneum*, var. *flavescens*, from Plant's Brook, all contributed by Mr. R. M. Lloyd; and a collection of cones and olives, forming the second part of a series of foreign shells, presented to the Society by Mr. Keen, of Liverpool.

At a subsequent meeting, Mr. S. Allport also contributed the first instalment of a series of minerals, forming the constituents of igneous and metamorphic rocks; 1st, the group of Felspars, including specimens of Orthoclase, Albite, Oligoclase, and Labradorite, with the varieties Adularia and Sanadine: 2nd, Pyroxenic minerals, comprising Augite, Hornblende, Bronzite, Diallage, Hypersthene, Actinolite, Tremolite, with specimens of Mica, Quartz, Leucite, and Nephelite; also some of the Zeolites most frequently found in cavities of the older igneous rocks, and the minerals Tourmaline, Epidote, Garnet, Idocrase, Chlorite, and Spodumene.

Mr. J. Bagnall exhibited *Tortula papillosa*, and several other mosses, not previously recorded as occurring in the district, and on behalf of Dr. Braithwaite, *Andræa rupestris* and *A. obovata*, two recent additions to the British Flora, from Glen Callater; Mr. E. Myers contributed fragments of boulder and wood from Boulder Clay at Sefton Park, near Liverpool, and described the Drift section in which they were exposed; and Mr. E. Simpson laid on the table thirty species of marine mollusca taken on the coast of Jersey.

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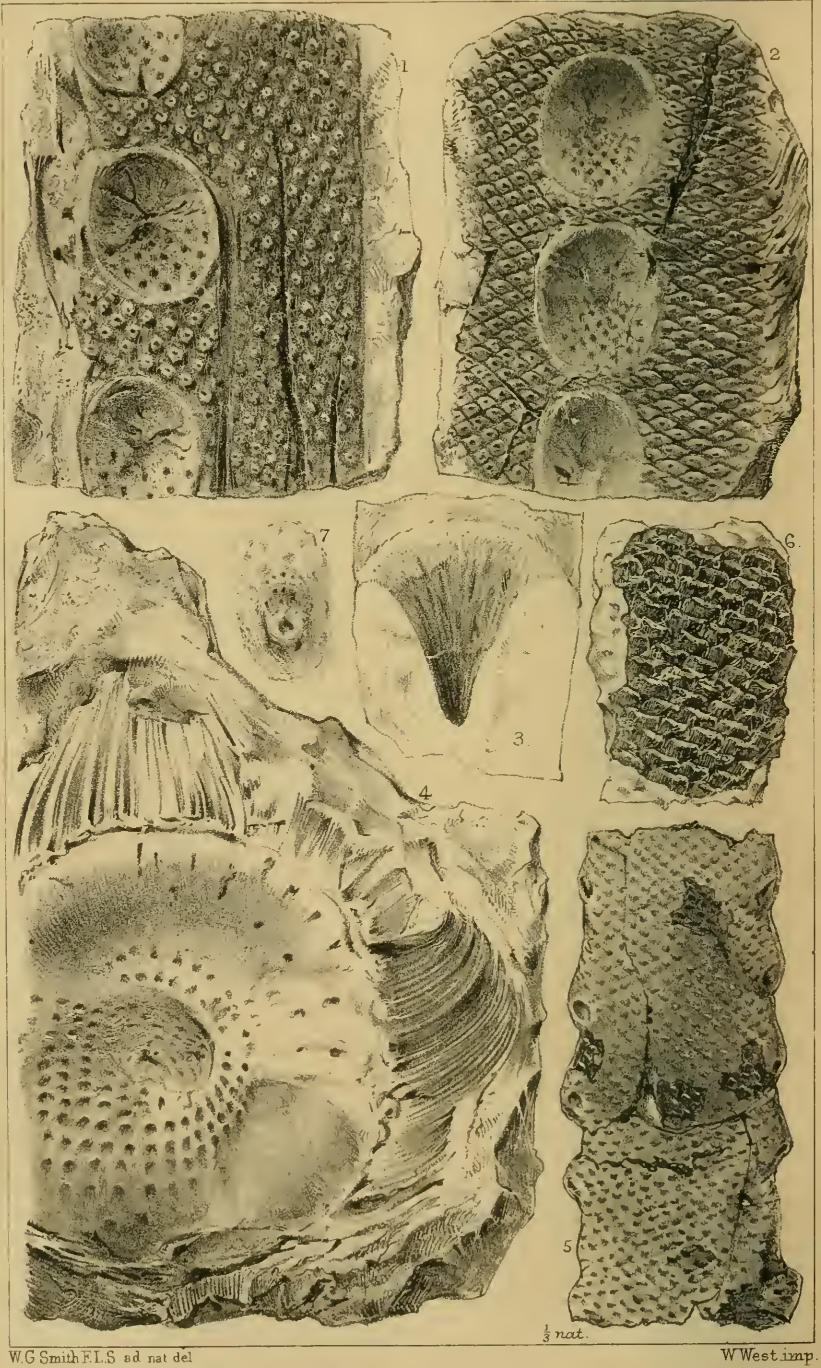

W.G Smith F.L.S ad nat del

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Fig. 1. Ulodendron Taylori, sp. nov. 2. U. pumilum, sp. nov. 3. U. minus Lindl. & Hutt. 4. U. majus, Lindl. & Hutt. 5-7. U. tumidum, sp. nov.

THE

MONTHLY MICROSCOPICAL JOURNAL.

MARCH 1, 1870.

I.—THE PRESIDENT'S ADDRESS.

(*Delivered before the* ROYAL MICROSCOPICAL SOCIETY, *February* 9, 1870.)

GENTLEMEN,

A statutable generation has nearly passed away since the first felt want of organization among microscopists issued in the formation of the Society over which I have now the honour to preside. To me, therefore, it seems natural to look back upon the past, and I will gladly carry my hearers along with me while I turn my sail up the stream of life under the cheerful gale of pleasant memories. It is now more than thirty years since the honoured father of our Society, Dr. Bowerbank, assembled what he called a "band of brothers" for the weekly investigation of microscopic objects, with special reference to structure, functions, and laws of formation. The animal, the vegetable, and the mineral kingdom were brought under review by pioneers of science, and the early fruits of their discoveries promised an abundant harvest. The cherished names of Lindley, Mantell, Lister, Henslow, Ward, Quekett, Bell, and of other leading investigators in the branches of physical science, where the microscope is an indispensable instrument for research, will be a guarantee, not for vague speculations, but for the establishment of new facts and the extension of positive knowledge. Could it be possible to collect within moderate compass an account of the weekly labours of Dr. Bowerbank and his zealous collaborateurs, not only would there be a present testimony to the value of their early work, but it would be at once apparent that the philosopher's *sanctum* within which so many were assembled was too limited in dimension, and that the law of cell-formation must perforce be called into requisition. Accordingly, after a large and most interesting meeting, specially assembled to greet our Honorary Fellow, Ehrenberg, Dr. Bowerbank said to me with a warmth of feeling I shall never forget, "God bless the microscope; let us have a Society." A hearty response was given on my part when Dr. Bowerbank added, we will call the Society the Microscopic Society. I suggested *Microscopical* instead of *Microscopic*, as being more in accordance with the analogy of nomenclature, and preventing the possibility of ourselves being mistaken for microscopic objects. This was admitted, and hence our name. An arrangement was made in due course for drawing up suitable rules and laws, and after a few preliminary meetings at Messrs. Bowerbank's, Quekett's, and Ward's, the "Microscopical Society of London" had both a local habitation and a name, under the presidency of Professor Owen, on the 29th of January, 1840.* From this date the appointed monthly meetings of the Society were regularly held, but the Monday evening meetings at Islington and Highbury were not yet interrupted. There the net was still spread, and the bait, too tempting to be refused, seldom failed to prove the skill of the angler in adding new members to our body. The varied treasures of well-arranged cabinets were always open for inspection, so that those—and they were many—who brought new objects of interest, received an ample equivalent in the knowledge they carried away. Many fields of microscopical research, now indeed well trodden, were then only just ventured upon by a few; and it will always be a pleasant recollection to Dr. Bowerbank that he was able to offer efficient assistance to the authors of valuable works, which tended in no small degree to advance microscopical investigation. Many of the objects figured by Mantell in his 'Wonders of Geology' and 'Medals of Creation,' were first of all exhibited to Dr. Bowerbank and his friends; and Professor Owen derived no small assistance both from Dr. Bowerbank's microscope and my own, in the exquisite drawings by Lens Aldous

* Extract from the first Historical Document in the Archives of the R. M. S.

"At a meeting held at the house of E. J. Quekett, Esq., Wellclose Square, September 3rd, 1839, to take into consideration the propriety of forming a Society for the promotion of Microscopical investigation, and for the introduction and improvement of the Microscope as a scientific instrument,

"Present, the following gentlemen:—

Rev. J. T. Bean,	Mr. E. J. Quekett,
Mr. J. S. Bowerbank,	Rev. J. B. Reade,
Dr. F. Farre,	Mr. Rippingham,
Mr. Francis,	,, Ross,
,, Greening,	,, R. H. Solly,
,, Jackson,	,, C. Varley,
,, Lister,	,, N. B. Ward,
,, G. Loddiges,	,, A. White,
,, C. Loddiges,	

"It was resolved, that such a Society should be formed, that a provisional committee be appointed to carry the resolution into effect, and that the said committee do consist of the undermentioned gentlemen, *viz.*:—

Messrs. Bowerbank, Lister, Loddiges, Quekett, Reade, Solly, and Ward.

"The provisional committee having held several meetings, it was resolved, that the following Rules and Regulations be recommended for adoption:—

"1st. That the Society be designated 'The Microscopical Society of London.'"

Then follow twenty Rules, which were adopted at the first public meeting, under the presidency of Professor Owen.

of the sections of teeth which embellish his 'Odontography.' Of three of these sections I made enlarged photographs in 1839, for the artist's guidance, by means of the solar microscope, under such an arrangement of lenses that no danger could ensue from the heat-giving rays; and presentation copies of proofs of many of the plates, and also of Professor Owen's work on the Kangaroo will always be valued by me as a memento of those early days. Many papers also on the minute structure of fossil and recent plants owed their origin to these weekly meetings, and it will suffice to add that the elaborate work on Sponges, which even now is adding to the honour of our good friend's honoured name, is the fruit of the good seed sown thirty years ago. And happily the author is still with us and at work. The *cruda viridisque senectus*—his good and green old age—is still devoted with almost youthful ardour to his early love; while his ripe experience enables him to recognize more devoutly the hand of the Great Master, and to bid "God speed" to the Society which specially investigates His works. The few, alas! the very few of our original members who still remain on our list, will, with myself, refer with mixed feelings to this our early history, while the younger Fellows will be glad to find these few historical particulars for the first time officially recorded.

I have stated that Dr. Bowerbank is the father of the Microscopical Society. Perhaps I may be looked upon as a godfather and sponsor, inasmuch as I named the child; and now that it has arrived at maturity, it is my duty to see that in ripeness of age it may attain to perfectness of knowledge. To perform this my duty efficiently, and to give some proof of my abiding interest in the present and future welfare of the Society, it is my intention to place in its Library my own copy of the 'Philosophical Transactions.' In the perusal of this great work your minds will be filled with thoughts of other men; and after due meditation and study, they will be also replenished with your own. The unavoidable result will be a large accession of valuable papers at our meetings on topics peculiarly ours.

My first seventeen volumes of the 'Transactions,' from the commencement in 1665 to 1694, representing as it were the *Eocene period* of microscopical investigation, are *in extenso* as originally printed. Then follow ten volumes containing the 'Transactions abridged.' The first five volumes are by Lowthorp and Jones, under the *imprimatur* of Sir Isaac Newton as President. The remaining five are by Reid, Gray, and Martyn. In these volumes the papers are disposed under general heads, and the Latin papers are translated into English. This 'Abridgment' contains the 'Transactions' from the commencement to 1750. From this date the publication of the 'Transactions' was placed under the special direction of the Society itself, and not left, as heretofore, in the hands of the respective secretaries, and my own copy is complete from 1751 to the present year 1870.* There is also an Index, both of authors and subjects, from the commencement to 1770, with *references* to the 'Transactions at large' and to the 'Abridgment;' and to complete our means of reference, not only to the 'Transactions,' but to many other philosophical works, both English and foreign, published during the present century, the Royal Society has generously added to our Library its 'Catalogue of Scientific Papers' now in course of publication.

I wish also to present to you my copy of the 'History of the Royal Society,' by Dr. Sprat. This learned Bishop of Rochester informs us in his preface that, owing to the objections and cavils of detractors, he writes not altogether in the way of a plain *history*, but sometimes of an *apology;* and it may be said of the Bishop, in the language of an author of the period,—"Taking to task that insulting question, *What have they done?* he gives an answer to it, which doubtless will satisfy discreet and sober men. And as for those that would have them give the *Great Elixir*, the *Perpetual Motion*, the way to make *Glass Malleable*, and *Man Immortal*, &c., or they will object *they have done nothing;* for such, *he saith*, their impertinent taunts are no more to be regarded than the *chat of idiots* and *children*."

But the Bishop had not only to meet detractors like these; he had also to vindicate the design of the Royal Society from the imputation of being prejudicial to the Church of England. And he finds it easy to point out the agreement there is between the design of the Royal Society and that of our Church in its beginning. "They both," says his Lordship, "may lay equal claim to the word *Reformation;* the one having compassed it in *Religion*, the other purposing it in *Philosophy*." And how this purpose has been carried out we ourselves are witnesses. Many reverent and master-minds, from Newton to the present day, have received in their study of the Book of Nature an illumination from the Great Author of Nature no less specific and manifest than that divine illumination which enabled Prophets and Apostles to indite the Book of Revelation. Hence, an enlightened philosopher can now point out, in terms unknown to the Early Church, *How* "the heavens declare the glory of God, and the firmament showeth His handy work,"—while, under an unerring inspiration, it is announced to us that "the law of the Lord is perfect, converting the soul."

I almost shrink from giving any historical account of the many portions of the 'Transactions,' specially interesting to ourselves, as I would rather avoid the *Scylla* of a mere index of authors, and the *Charybdis* of a too extended account of their works. Suffice it to say that our lamented President, Professor Quekett, has given us,

* A few parts now in the *limbo* of borrowed books will be replaced.

in his 'History of the Microscope,' copious extracts from these volumes, which literally teem with improvements in the construction of this instrument, from the very first published paper—*viz.* 'An Account of the Improvement of Optic Glasses by Campani'—to the recorded discovery of Mr. Lister, who raised the compound microscope from its primitive and almost useless condition to that of being the most important instrument ever yet bestowed by art upon the investigator of Nature. I would rather commend for your frequent and profitable perusal the whole 'Transactions of the Royal Society,' extending over more than 200 years. They are a mine of intellectual wealth; and the zeal and determined labour of those who drill and bore the solid earth for that gold for the body which perisheth, may be held up for the imitation of those who desire more anxiously gold for the mind. With these few observations I offer you this great commentary on universal nature, while, as a Fellow of your Society, I still retain the virtual possession of a gift now absolutely your own.

I connect at once the present with the past in addressing you now as "FELLOWS of the Royal Microscopical Society." The change in our designation and the charter which led to it were alluded to as simple facts by my predecessor in the chair, and that with a modesty which I am not bound to imitate, inasmuch as it concealed his own claim to the honour of procuring these privileges. Five years ago, at the official meeting of the Council, my predecessor strongly urged that my name should be placed first in the selected list of officers for the following year; but I knew myself, and I knew my friend; and it will be admitted by all that I exercised a wise discretion in then refusing the proffered honour, and in joining heartily with the Council in securing for our Society the untiring energy and practical knowledge of business which have enabled our late Chief Officer to leave behind him in uneffaceable characters the marks of Royal favour in the title "Royal" which Her Most Gracious Majesty conferred, and in the distinguished honour of receiving H.R.H. the Prince of Wales as our Patron. It is therefore but a just debt of gratitude, after his doubly biennial occupation of the chair—*viz.* during the last two years under our first condition and the first two years under the higher standing of our Society—that I should now offer to Mr. Glaisher, in the name and on behalf of the Society, our cordial acknowledgment of his faithful services, and our hearty good wishes for his future welfare.

The three oldest members of your Society, who were mainly instrumental in its formation, and who therefore had the honour of applying for a Royal Charter of Incorporation, were Dr. Bowerbank, Mr. Ward, and myself. The last address from the chair announced the death of our dear and valued fellow-worker and first treasurer, Mr. Ward; and it is now my painful duty to record the loss of another of the associated founders of our Society, and to add to our obituary the name of Joseph Jackson Lister. Full of years and full of honour he rests from his labours; and it is the consoling testimony of the friends who witnessed the perfect calmness of his departure that he enjoyed that peace of which it is enough to say that it "passeth all understanding."

During the past year we have lost four Fellows by death, *viz.*:—Mr. Joseph Jackson Lister, F.R.S., Z.S.; Mr. Henry Hall; Mr. George Western, and Captain John Gould Noble; also one Honorary Fellow, Professor Purkinje, of Prague. We have lost six Fellows by resignation. The number of Honorary Fellows has been increased by two, and of Ordinary Fellows by twelve. At the present time our total number is greater than in any preceding year, being now 458.

In a long letter received from Professor Lister to-day I am furnished with important particulars regarding his late dear and honoured father. This obituary notice, through the medium of our Journal, will be placed in the hands of all our Fellows.

The points of special interest to our Society are naturally connected with the improvements Mr. Lister effected in the microscope; and owing to the admirable arrangement of his original MSS. and letters, we have here, in his own words, a detailed history of his experiments and discoveries from 1824 to 1837. When he saw his principles of construction practically carried out, he devoted his leisure to various investigations by aid of the instrument he had so greatly improved; and his well-known observations "On the Structure and Functions of Tubular and Cellular Polypi and Ascidiæ," beautifully illustrated by sketches from life under the camera lucida, form a classical paper in the 'Philosophical Transactions' for 1834.

Some important papers of Mr. Lister's, still unpublished, will, we may hope, be given to the world.

Our list of Honorary Fellows commenced with the names of Professor Ehrenberg and the late Professor Purkinje. These distinguished philosophers were elected at the first anniversary meeting of our Society in 1841. Professor Purkinje, of Prague, unlike his illustrious compeer of Berlin, was not a contributor to our 'Transactions;' but his valuable physiological researches, continued throughout a long and active life, place him among the most celebrated observers of modern times. He died on the 28th of July last, in the eighty-second year of his age.

Mr. Hall, Mr. Western, and Captain Noble, whose loss we also deplore, took great interest in microscopical literature; and Mr. Hall will be especially remembered among the circle of his friends as having zealously promoted microscopical investigation at Hackney.

A few words *in memoriam* respecting the late Mr. Holland, who, though not officially *of us*, uniformly worked with us, will be received, as a due tribute to the zeal of one of our oldest friends.

Mr. Holland commenced life as a clerk to a ship broker, and afterwards started in business, first as a partner, and then alone as a wine merchant on Tower Hill.

He was always ardently attached to science, and every moment he could spare was devoted to some pursuit connected therewith. As early as 1822 both the telescope and microscope seem to have been passions with him. For a long time his best microscope was a small compound one by Cary. To this instrument he added the first rectangular movable stage. Afterwards he began to construct and use very perfect globules of glass as objectives in a single microscope made on a plan of his own, and having caused some of these to be ground plano-convex, his continued study and experiments resulted in the manufacture of some excellent Wollaston *Doublets*, and afterwards in the *Triplet* with which his own name has since been connected. The Triplet carried the single microscope to its highest point of excellence, and for its discovery the Society of Arts awarded him its Silver Medal.

At the time Mr. Barton made the beautiful specimens of fine lines which are seen in the buttons now bearing his name, he ruled, at the request of Mr. Holland, some exceedingly fine micrometers, which bear comparison with any recent productions.

In September, 1833, he opened an exhibition of a gas microscope, at 106, New Bond Street, which continued till July, 1834. This instrument greatly surpassed the first arrangement exhibited by Cary and Cooper in the previous year, inasmuch as the error of spherical aberration was neutralized by mounting the objects on curved glasses.

In his collection of apparatus there is a rectangular prism and a separate raised stage for sub-stage oblique illumination, and among his papers we find a careful series of observations by this arrangement on the *striæ* of various species of diatoms.

An ingenious speciality was the construction of polarizing "Floral Devices" for the microscope, some of which were made up of as many as 192 pieces stamped out of various polarizing films by a graduated series of minute punches, the connecting stems being formed of the hairs from the back of a child's hand, adult hairs being too coarse. One of these is most kindly presented to our Society by Mr. J. Lyon Field, the present possessor of Mr. Holland's microscope and objects.

His latest investigations were on the specific microscopic characters of the virus of the cattle plague, illustrated by mounted specimens and careful drawings.

For the last thirty years he was in the counting-house of

Messrs. Field, of Lambeth, and his probity, methodical habits, and untiring attention to business, secured for him the personal respect and friendship of every member of the firm. His naturally vigorous constitution was at last undermined by chronic bronchitis, and he passed away in his sleep on the 15th day of November, 1869, and in the 77th year of his age.

At the eight monthly meetings held during the past session twenty-one papers have been communicated, *viz.* seven by friends of our Fellows, and fourteen by Fellows themselves.

The first paper in March, by the well-known and accurate observer, Dr. Gulliver, points out the unique character of the fibres of the crystalline lens of the lamprey, which appear to be smooth and not serrated. This departure from the general law of structure is very remarkable.

The exhaustive and elaborately illustrated paper by Mr. Suffolk, "On the Structure of the Proboscis of the Blow-fly," and the paper by Mr. Lowne "On the Rectal Papillæ of the Fly," are admirable specimens of patient investigation and manipulative skill.

Valuable communications in reference to minute anatomy and animal and vegetable physiology, by Messrs. Sanders, Kent, McIntyre, Carruthers, Wake, and Dr. Macintosh, have supplied us with new and useful information, and led to enlivening and interesting discussions.

In bringing before us the forms of gigantic *Lycopodiaceæ* belonging to the Carboniferous period, Mr. Carruthers set forth, in a very able *vivâ voce* exposition, the several points of agreement and difference between the immense stems of ancient cryptogamic forests and the stems of existing plants. During my own residence in Halifax, in 1829 and two following years, I had frequent opportunities of examining the *Lepidodendron selaginoides*, figured and described by Mr. Carruthers, and I can corroborate his statement that the fossil-bearing nodules, known locally as "*baum-pots,*" occur over a space of many acres. One of these *baum-pots*, now in the Halifax Museum, has entrapped, in the Coal-measures, about 12 inches of the skeleton and tail of an 8 or 10 lb. fish.* It was during my residence in Halifax that the British Association, of which I am now what is popularly known as "an old life member," assembled for the first time at York under the presidency of the Earl Fitzwilliam, and from that time to this our indebtedness, as microscopists, to a goodly company of members of the Association, will be acknowledged by us all. It is also gratifying to find that our own labours have been recognized by the Association, and we

* A plaster of Paris cast of this remarkable baum-pot fossil was sent to the meeting by Mr. Waterhouse, of Halifax. The fish is probably a fine specimen of the *Cœlacanthus Phillipsii*, described by Agassiz, having a cartilaginous vertebral column with bony *hollow appendages* (hence its name) and beautifully sculptured scales.

may hope that the lapse of twelve years gives additional force to the following words of our own first President in his *Address* at the Leeds meeting of the British Association:—" The microscope is an indispensable instrument in embryological and histological researches, as also in reference to that vast swarm of animalcules which are too minute for ordinary vision. I can here do little more than allude to the systematic direction now given to the application of the microscope to particular tissues and particular classes, chiefly due in this country to the counsels and example of the Microscopical Society of London."

At our meeting in April, Dr. Beale, treading on the very confines of the limit of human knowledge, brought a question before us which may very easily be answered on the ground of speculation, yet all but unanswerable on the basis of truth. What is *Protoplasm?* and, What is *Life?* In consequence of the penumbra of diametrically opposite definitions, Dr. Beale rejects the word *Protoplasm,* so much in favour with metaphysical physicists, and he enables us to look on at the battle of the giants vigorously destroying each other's theories but failing to establish their own. In propounding his own views concerning the *matter* of living beings, Dr. Beale restricts himself to the simple and expressive terms, *germinal matter* and *formed matter.* The former is possessed of *vital properties,* and the latter of *material properties* only. The rather striking difference between dead and living matter seems to justify the rejection of a term which is indiscriminately applied to masses of living things and dead things, and to warrant the use of other terms which are free from the mysteriousness of *protoplasm,* and which properly indicate matter existing in two very different states, *living* and *formed.*

Then, as to the question, What is Life? This much we know, on the highest authority, that Life is the direct gift of the Creator to the living creatures of His hands, and for perfect knowledge we must wait for the perfect day, when " we shall know even as also we are known." Meanwhile, the conscientious observer is amply justified in investigating the Law of Life as well as the Law of Gravitation, telling us, as it may seem to him, what it is and how it acts; and if he advance no farther than a plausible hypothesis, he may thereby direct us *Truth-ward* though he reach not the goal himself. We can place no limit to legitimate inquiry, nor refuse a hearty reception of well-established facts. At the same time let us bear this in mind, *Humanum est errare,* and it may be that universal error is received as practical truth,—but truth is not error for all that.

In the discussion of an allied subject, Mr. Staniland Wake strongly supports the view that the connection between the initial phases of animal and vegetable life is more fundamental than has hitherto been supposed,—that it is, in point of fact, a mere matter of chance, a mere question of conditions, whether a particular germ shall finally be exhibited as a true animal or a true vegetable. But this speculation on the most minute forms of existence ought to be supported by evidence which substantiates the hypothesis. Otherwise, in spite of the novelty which may be attractive to younger philosophers, the old faith will maintain its ground, that animal or vegetable life is in no case produced except from germs of individuals of the same species.

At our December meeting Professor Rymer Jones favoured us with a short *extempore* account of deep-sea dredging. This laborious operation is now carried on with equal assiduity and success. Ehrenberg, as Professor Owen states, had discovered that the substance of the greensands in stratified deposits, from the Silurian to the Tertiary periods inclusive, is composed of the casts of the interior of the microscopic shells of *Polycystineæ* and *Foraminifera*. But many soundings now brought up from various parts of the deep sea consist chiefly of similar microscopic polythalamous shells, mingled with a greensand composed of casts of *Foraminifera*. Therefore the mode in which a deposit was made at the bottom of the deep primeval ocean of the Silurian period is illustrated by that which the microscope has demonstrated to take place under similar conditions at the present day.

Thanks to the *monthly publication* of our 'Proceedings,' I am spared the regret of my predecessor, who naturally complained that in preparing his address he had not the advantage of perusing the papers communicated at the two preceding meetings. The papers are now posted up to the day, and the Journal for this month contains the four papers read in abstract at the meeting in January. The last of these is a long and most instructive monograph by Mr. Kent, "On the Calcareous Spicula of Gorgonaceæ, their Modification of Form, and the Importance of their Characters as a Basis for Generic and Specific Diagnosis." It is only very recently that naturalists have availed themselves of this new basis for a natural system of classification, and it is cheering to an old observer to see the tact with which a young microscopist exhibits Nature's modifications under Nature's law. Mr. Kent's paper, with nearly 100 charming illustrations of his subject, most of them heretofore unfigured, is a boon to microscopists, and stamps something far beyond a mere money value on the 'Monthly Microscopical Journal' for February.

Our thanks are due to Mr. Browning for two papers on the Spectroscope, and to our Hon. Secretary, Mr. Hogg, for his results of spectrum analysis. In the reported discussion on Mr. Hogg's paper, I should be glad to place *absorption bands* on a few expressions used by Mr. Ray Lankester, as their absence would add force to some of his criticisms. It is true, for instance, that alcohol alone is not the best menstruum for the chlorophyll of plants. A previous aqueous solution is desirable. Of this I have just had a striking example when examining the spectrum of the Japan honeysuckle. The dark purple skin of the fruit yields a purple solution to water, and its spectrum is marked by the obliteration of the red, with the exception of a curiously thin bright band untouched in the middle of the red,—the obliteration of the yellow and blue, and the exaltation of the green. The subsequent alcoholic solution of the portion first acted on by water gives a green solution of chlorophyll, and its spectrum is now characterized by a magnificent black band near the commencement of the red, over the line B,—a pale band in the green, and the cutting off of nearly all the blue. Whereas the spectrum of a primary alcoholic solution is a curious mixture of these two spectra.

Another striking example of the accuracy of spectroscope work was lately supplied by Mr. Sorby, to whom I forwarded the dichroic fluid exhibited at our last Soirée. Mr. Sorby clearly proves that a very different spectrum is produced by the addition of albumen to the confervoid mass, and hereby he establishes Mr. Sheppard's conclusions, and disestablishes Mr. Ray Lankester's assertions.

Mr. Browning's micro-spectroscope was lately added to our Ross-microscope. The spectroscope leads us into a new field of research, and the wonders revealed by this marvellous instrument are only dawning upon us. Already it converts the telescope into a celestial microscope, and in the hands of our distinguished Fellow, Mr. Huggins, now on the Council of the Royal Society, it enables him to deal with the constituents of some of the mighty spheres of the universe as if they were merely elements of the *Volvox globator*. Mr. Browning has recently improved the series of prisms, and also, in order to secure a reliable measurement of absorption bands, he has converted the instrument into a *micrometer-spectroscope;* and I have the pleasure of stating that Mr. Browning will put new and more powerful prisms to our own instrument, and will also add "the new measuring apparatus" as a present to the Society. Mr. Browning's communication on this subject was read at our last meeting, and we learn from it, in few words, that the micrometer-spectroscope determines the position of absorption bands by their accurately measured distance from Fraünhofer's fixed lines of the spectrum, while the ordinary micro-spectroscope determines their position by their distance from one of Mr. Sorby's 12 interference lines produced by a thin plate of quartz between two Nicol's prisms. Mr. Sorby's ingenious artificial scale is thus superseded by an unalterable natural scale.

With respect to the attempts brought before us to improve the microscope itself as an instrument of scientific research, I must refer to Dr. Royston-Pigott's paper "On High Power Definition," and to my own paper "On the Equilateral Prism." Considering a perfect microscope as consisting of two parts, a magnifying apparatus and an illuminating apparatus, Dr. Pigott proposes to weed out, as it were, an effective portion of the small residuary spherical aberration of the best objectives, and I have ventured to propose a principle of illumination which has not hitherto been avowedly advocated. When Dr. Wollaston recommended for an illuminating lens one of three-fourths of an inch in focal length, in which the microscopic object was placed in a vortex of foci, where the rays crossed in a thousand points both before and after they fell upon the object, he failed to realize the true method of illumination. Spherical and chromatic aberration are equally injurious in either of the essential parts of a microscope. The equilateral prism used as a condenser and the hemispherical lens used as a prism, are free from both these errors. They supply, the one a condensed, the other a simple, single beam of parallel light; and a microscopic object, under such illumination, has virtually the advantage of being illuminated as by the sun. Natural light and shade are secured, and objects, like the valves of the Diatomaceæ, which hitherto have been shrouded in a haze of interpretations, are truthfully presented to the observer. I therefore look upon the prism as a kind of "*Zaphnath-paaneah*," a revealer of secrets.

Dr. Pigott's work is more arduous, and it certainly met in the first instance with an encouraging amount of opposition,—encouraging, I mean, to one who knew—and was prepared to defend—the right. For my own part, I must honestly say, and I am not alone in my opinion, that I did not believe a word of it. In point of fact, I was sure that Dr. Pigott's "beaded scale" was not the true *test scale*. True, we were all taken by surprise and uttered our criticisms freely, yet, in my own defence, I must be allowed to say that I do not concur in the personal comments reported in our 'Proceedings' and now willingly cancelled. I felt, however, that I had sat too long at the feet of my old friend, Andrew Ross, to admit the possibility of his good work being vitiated by this newly-announced error, and what I did not look for I did not find,—but only because I did not look for it, not because it did not exist. There is undoubtedly in our best objectives a residuary spherical aberration,—small, I admit,—but it is unnecessary to say to a microscopist that its injurious effect upon the magnified image of an object varies directly as the square of the power of the eye-piece. It would be beyond the scope of a President's Address to point out how this small but injurious amount of error may be detected and diminished. This must remain as a fundamental problem in the *Optician's Euclid*. It is enough to record *the fact of improvement* as one of the salient points of the year. I will therefore only add that those who, like myself, have seen Dr. Pigott's exhibition of the beaded scales of *Lepidocyrtus curvicollis* and *Degeeria domestica*, can only sincerely thank him for taking the trouble to compel us to believe that a successful raid upon the existing trace of spherical aberration is not a myth.

The immersion lens, the "hydro-objective," has probably an advantage in "the battle of the glasses" over the "pneumo-objective," as pointed out by Dr. Pigott; and Mr. Ross has laid us under further obligation by kindly adding immersion-fronts to his $\frac{1}{8}$th and $\frac{1}{12}$th in our possession. The high praise, however, which is given to the immersion system will perhaps be received with caution until more extended observations have been made upon its powers. Yet all seem, at present, to admit that considerable advantages are gained by its use. The light is more abundant, the colouring of natural objects more brilliant, the definition keener: inferior glasses are frequently improved by its application: illumination can be more effectively employed with a less complex machinery of stops, diaphragms, and condensers: above all, facility of construction seems to be indicated by the offer of the highest powers at the lowest prices. This intimation comes from the Continent,—*A* $\frac{1}{12}$*th for fifty shillings!* Is such work possible at home? Still we have yet to learn, notwithstanding these acknowledged advantages, whether there are any considerable drawbacks looming in the microscopic future which may in some measure counterbalance the employment of water refractions. Of one thing we may be sure, that absolute perfection is unattainable. The ghost of aberration will never be entirely exorcised even by cold water. It is there —do our best—and after all our compensations for figure, as for colour, there ever must be a little ghost of an error in all probability. At the same time, I believe it to be reduced to the *minimum visibile* when the *colour test* so strongly advocated by Dr. Pigott is fairly exhibited on the stage. Thus the natural colours, for instance, of the upper and lower rows of beads on the scale of *Degeeria plumbea* seem, for the first time, to be brought out by Dr. Pigott's more accurate balance of positive and negative aberrations. But this part of the subject is extensive, and must be left for further research and observations.

It is proper to remark that Colonel Woodward has resolved the 19th band of Nobert's lines with a Powell and Lealand's $\frac{1}{16}$th immersion. He is the only observer who has succeeded in resolving 112688 lines to the inch, with a power of 1000 linear. But these lines present the same appearance as lines drawn about 112 to the inch would afford at a distance of 10 inches, to the ordinary sight,—which are evidently exceedingly close for numeration. No other powers in Colonel Woodward's possession could resolve this 19th band, and this is a strong fact in favour of the immersion system. But even here diffraction lines are multiplied, and the visibility of the lines is a function of the breadth of the groove ploughed in the glass,—the depth to which it is cut,—the sectional shape of the groove itself,—and the direction and character of the illumination employed. All these variable conditions in some measure detract from the fixed value of this test. It ought to depend upon the uniformity of standard conditions. The *Acus*, as shown by Mr. Powell, is a sharper and safer test.

A valuable series of papers by Mr. Wenham, "On the Construction of Object-glasses for the Microscope," will be found in the 'Monthly Microscopical Journal' for 1869. These papers were considered by the author to be communications to our Society; but, owing to their nature and arrangement, the formal reading of them was, at his request, dispensed with. It is acknowledged by all opticians that Mr. Lister's introduction of the *triple-back*, *i.e.* the innermost of the three combinations, has proved "the grandest step" towards the perfection of the compound objective. Mr. Wenham was no doubt the first to connect with this new back a lens nearly hemispherical, instead of the cemented triple front. Mr. Wray, following closely but independently in his wake, used what he calls "the kettledrum system for front" so early as 1851. It gives confidence to observers when they find that able men are driven by the necessities of the case to work by almost the same rules. Accordingly I received with pleasure a note from Mr. Wray, in which he says, "Judge of my surprise when I read Mr. Wenham's first paper, and found he was using a form very nearly similar to my own." Mr. Wenham points out very forcibly that the single front has the advantage of facility of construction, and also gives command over any required extent both of aperture and power. When we find the diameter of a single front to be only the $\frac{1}{70}$th of an inch, Mr. Wenham may well say, "The difficulty if not impossibility of constructing a *triple* of such almost invisible atoms of glass may be imagined."

Despairing of taking up the subject again practically, Mr. Wenham leaves, as a legacy to opticians, an improvement even on the single front, and proposes to construct the higher powers with two single lenses in front, of equal radius. If these are set in contact, the magnifying power will be nearly as their sum; they may therefore be made of double the radius, and consequently nearly twice the diameter, which, of course, would lessen the practical difficulty of working a $\frac{1}{50}$th, and enable us to go even beyond this power. A partial experiment with a $\frac{1}{4}$th, having this "doublet" front, has proved that perfect correction for colour is the result. Our leading opticians will no doubt thankfully avail themselves of these suggestions of an amateur labourer whose masterly knowledge of the subject and almost unrivalled practical skill fit him to speak *ex* *cathedrâ.* The Society also will learn with regret that Mr. Wenham is now unable to take his place amongst us and to add, as heretofore, to the interest of our discussions.

Among the many valuable presents received during the past year, the Amici reflecting microscope, presented by Dr. Millar, requires a special notice. As Holland's *Triplet* was the culminating point of the single microscope, so the *Amici Reflector* was a stand-point in the history of the compound microscope. It is not too much to say that the compound microscope had been in what we may term an embryo state for a period of nearly 200 years. Griendelius in 1687 published in his work on the Microscope a diagram and an account of a compound microscope, the compound positive eye-piece consisting of two pairs of plano-convex lenses placed with the convex surfaces towards each other, an arrangement superior perhaps to Ramsden's, and, what is very remarkable, the object-glass of that early microscope is compound also, consisting of two plano-convex lenses of short focal length, as in Wollaston's celebrated *doublet*, the convex surfaces being hyperbolic curves. Spherical aberration, however, would necessarily confine such a construction within the limit of low powers, and the achromatic objective had not yet become a matter even of mathematical speculation. Errors from curvature and colour seemed for a long time to be looked upon by opticians as a *sine quâ non*, and to be accepted as an inherent and irremovable blot upon their work. Nor did mathematicians get them out of the scrape until Amici, in our own day, threw the refracting medium overboard, and, after the example of Newton, used a small speculum for high and low powers. In the exterior of the Amician microscope there is indeed a *primâ facie* resemblance to a Newtonian telescope; but, as Dr. Goring justly remarks, "the form of the concave metal and the situation of the radiant point are so totally different as to constitute a new instrument."

The instrument presented to the Society by Dr. Millar was made by Cuthbert. Dr. Goring gives a very minute description of it in his 'Micrographia,' speaking of Cuthbert and himself as "the parents of the instrument *in its effective form.*" I was fortunately able to complete Dr. Millar's instrument by adding to it the deeper objective metals, and these, in Dr. Goring's opinion, became invaluable when Cuthbert's loss of sight stopped his work. Yet, under my own eyes, this good old man when blind, but owning an inner light, figured to perfection a small speculum for my Gregorian telescope, saying with the blind old poet, "Yet not the more bate I one jot of hope, but hold right on."

As the triplet gave place to the more aplanatic speculum, so the latter was ultimately superseded by the Achromatic objective. Wm. Tulley was the first among English opticians to produce a single uncemented achromatic triple, $\frac{9}{10}$ths of an inch in focal length. This was effected for Dr. Goring, but only after such an amount of "trial and error" that the cost of labour alone, as Tulley informed me himself, was not less than 90*l.* on the first object-glass. The record of this fact is interesting.

The present prosperous condition of our Society not only in the number of our Fellows but in their working power and its efficient results cannot fail to be a source of satisfaction. It is also gratifying to know that our influence during a period of thirty years has been largely felt by other bodies of scientific men, both in London and the provinces; so that there is hardly a town of importance in the length and breadth of the land without its co-operative Microscopical Association. In the large centres of commercial enterprise and industry our own labours find a parallel in theirs, and our once infant Society is now surrounded by a host of kindred institutions, joining with ourselves in the minute and accurate investigation of Nature's laws and works. But in looking at the extent to which the leaven of our influence has operated, it is impossible to omit a tribute of admiration to the "State Microscopical Society of Illinois," for which a charter was procured at the last Spring session of the legislature, and published *in extenso* in the 'Chicago Times' on the 12th of April last. Your President and Mr. Durham, as the President of the Quekett Club, were invited to be present last May at the first great gathering of this new Society, when an address of no ordinary interest and power was read from the chair. This address commenced with a condensed account of microscopy as to its antiquity and its progress in modern times, and then more fully described the status of the Royal Microscopical Society of London, and its influence upon science, literature, and optical art. After alluding to the increasing number of scientific journals ably edited and abundantly supported, and also to our own and other 'Transactions' admirably printed and illustrated, the President observed that "the influence of such a tidal wave on the interests of science must be at once apparent. Nor," says he, "did the usefulness of the parent Society (for such the London Society may justly be called) end here. From its formation it has given such an impetus to the optician's art as to have produced a keen but friendly competition, which has resulted in a degree of perfection deemed impossible a few years ago,—a competition which is, year by year, producing the most marked benefits to science, and, therefore, to the world."

The President then alluded to the past and present condition of Chicago, and to the marvellous change both in the face of the country and its population, which seems to us, on this side the Atlantic, more like a new creation than the following out of any natural law. He writes as follows:—"The time-honoured saying of good Bishop Berkeley, 'Westward the star of empire takes its way,' is as true in science as in material things, Thirty years ago, when the founders of the London Society met together, the city in which we live was little better than a swamp. Ten years later, when the writer first saw it, it was despised even by the cranes. The only decent tavern where the traveller could find 'native rye' with a strong smack of 'fusil,' was the old Sherman House, opposite which, in a wooden erection, 10 by 12, presided the Hon. Hugh J. Dickey, as Judge of the Circuit Court of Cook County, surrounded by such *an aborigines bar* as would lead the more civilized spectator to doubt whether they were the exponents or the examples of the criminal code of the State. But the old times have fled; and now, in a well-ordered city with its 300,000 inhabitants, on this 30th day of May, 1869, we are able to note that just thirty years from the foundation of the first Microscopical Society of which we can find any record, we have with us, in all the pride and pomp of circumstance, The State Microscopical Society of Illinois."

The proposed cultivation of microscopy by this young but far-seeing Society contains useful hints to those who have been longer at work. Already special committees have been appointed for the systematic investigation of floral structures, cryptogamous plants, vegetable and animal histology and pathology, vegetable and animal parasites, infusoria, crystallography, and kindred branches. Besides which it is desired to make the Society useful in social and commercial interests, by detecting adulteration in food and fraud in fabrics, and to exhibit from time to time, so far as may be possible, to such of the citizens as may appreciate it, the minute handiwork of the Creator, as it can be seen in no other way than through the almost infinite vision of the microscope. Such, then, is the vigorous impulse which our parent Society is admitted to have given during the past year to microscopy, in the great commercial centre of the State of Illinois.

In accordance with an intimation made to you at our last anniversary, your President and Council, in the early part of our present session, were permitted to lay before the Chief Commissioner of Public Works and Buildings their formal application for apartments in some building appropriated by Government for the use of learned societies.

It was stated to the Chief Commissioner that the Royal Microscopical Society, from the date of its foundation in 1839, has efficiently contributed to the advancement of the various branches of science which the microscope is capable of elucidating, and that the very high degree of perfection obtained by English opticians in the construction of microscopes, and apparatus pertaining thereto, has mainly resulted from the labours of Fellows of the said Society, in devising plans, supplying formulæ, and generally stimulating a demand both for first-class instruments, and, what is of equal importance, for those of an educational character.

That the Society, now numbering more than 450 members, has for many years published, and continues to publish, records of its Transactions and Proceedings, and has accumulated a valuable Library of Microscopical and Philosophical works, and a large collection of objects, preparations and instruments.

That many of the researches promoted by the Society have a direct bearing upon questions of public health, the propagation and prevention of disease, the adulteration of food and medicine, and the detection of frauds upon the excise, and that the assistance and counsel of Fellows of the Society have been sought by official persons in departments of the public service where the microscope is in frequent use.

That the Society is under the special patronage of His Royal Highness the Prince of Wales, and has received in the title conferred upon it a distinguished mark of Her Most Gracious Majesty's royal favour.

The Chief Commissioner of Works, acknowledging his own personal interest in the advancement of Microscopical Science, very kindly submitted for the inspection of the deputation a plan of the new buildings at Burlington House, and he expressed his regret that all but one set of apartments at the top of the building had been appropriated to the larger wants of other Societies by the former Government. He also pointed out certain alterations which might be made in the plan for the more convenient arrangement of our library and instruments, and intimated his wish that application should be made to the Linnean Society for the occasional use of their own meeting-room. At the same time, while expressing a decided opinion as to the propriety of our application, the Chief Commissioner of Works distinctly stated that the uncertainty which hung over the whole business—the contract even had not been signed—prevented him from formally committing himself to a definite promise of the apartments, and he hoped we should be satisfied with the statement he had made.

Your Council cannot but feel that the sincere regret expressed by the late Chief Commissioner at not being able to make a definite promise, and the recollection of his very courteous and friendly reception of the deputation, form the best ground for hope that the present Chief Commissioner of Public Works, at the proper time, will kindly gratify the Society by a grant of the apartments in question.

The historical character of my Address suggests a few remarks on the publication of our 'Transactions.' 'The Microscopic Journal,' edited by David Cooper, in 1840 contained the first brief record of the 'Proceedings' of our Society. In the first volume we find the important statement that the papers read at the several monthly meetings had all been presented to the Society by the respective authors, together with a portion of the drawings, diagrams, and specimens by which they had been illustrated. These papers, with others which have since been read, but never published, are duly deposited in the archives of the Society, and a catalogue of such communications and illustrations will be forthwith prepared. In the first annual address from the chair, Professor Owen reviewed at considerable length the previous monthly contributions to microscopic science in reference to minute anatomy, animal and vegetable physiology, zoology, and palæontology; but beyond short abstracts of some of these papers in the 'Microscopic Journal,' the only reference to them is contained in the President's address. An official catalogue of our MSS. is therefore a desideratum.

'The Transactions of the Microscopical Society of London,' published by Van Voorst in three volumes, and issued to members gratis, contained a selection of the papers read before the Society during the first thirteen years of its existence. The nine parts of this work contained on an average about six papers and five plates for each year; but such was the tardiness of publication, that the first part of vol. iii., published in 1850, contained two papers read in 1847, and three read in 1848. This quiescent period was closed in 1852 by the publication of the Quarterly Journal. With reference to this publication it may be stated, as a matter of history, that Mr. Samuel Highley, then associated with his father, observing that the 'Transactions' of our Society appeared with great irregularity and at increasingly long intervals, thought that a journal devoted to microscopy, published regularly every quarter, would be welcomed by the increasing number of persons interested in the microscope, whether as an instrument of rational amusement or of earnest research. He felt convinced, however, that the elements of success depended upon leavening purely scientific matter with a sufficiency of popular articles and memoranda to enlist the support of a large number of histological amateurs, without whose aid the existence of a scientific periodical would be impossible. Dr. Lankester and Mr. George Busk were then invited by the proprietors to become the editors of the projected journal. The prospect of a more speedy publication of our papers secured the co-operation of our Society, and the first number of 'THE QUARTERLY JOURNAL OF MICROSCOPICAL SCIENCE' was launched in October, 1852, with the promise of contributions from very many microscopists of note in the United Kingdom. In the first instance the 'Transactions' of the Society, as published in the Journal, were issued gratis to the members as heretofore, and 1*s*. per quarter was charged to those who received the additional matter also. This arrangement was the sole cause of the *separate paging* of the two distinct portions of the Journal.

In the following year the Society agreed to take 200 copies of the Quarterly, and to deliver the whole free of charge to all the members. This better arrangement had a marked influence on the success of our Society, for within a few months our muster-roll was satisfactorily increased by sixty-seven additional names. Nor is this to be wondered at when we recollect that every member received an admirably illustrated Journal, worth 16*s.*, as well as the other advantages of membership, for the small subscription of one guinea.

Too high a charge was demanded, however, by the subsequent publishers for extra numbers of the Journal, since it appears by a reference to our Journal account, that while the cost of the Journal was 84*l.* in 1856 to meet the requirements of 241 members, it was more than 184*l.* in 1862, though in this interval our members had increased by seventy-six only. This losing game put such a strain upon our finances that, in spite of a small improvement effected in subsequent years, your Council eventually gave legal notice to terminate the agreement for the publication of our 'Proceedings' and 'Transactions' in the Quarterly Journal; and in conformity with their resolution the connection of the Society with that Journal ceased with the publication of the October number in 1868. An arrangement was then made with Mr. Robert Hardwicke for the issue of a *Monthly Journal*, to commence on the 1st January, 1869, to be edited by Professor Lawson, M.D., and to contain, in addition to the matter furnished by the Society, an ample digest of British and foreign histological research and microscopical intelligence. The cost to the Society for 450 copies is 20*l.* per month, additional copies being charged 1*s.* each. Hence, while the cost of the Quarterly Journal, worth 16*s.* per annum, was 186*l.* in 1862, to meet the wants of 317 members, the Monthly Journal, worth 18*s.* per annum, was supplied for 240*l.* to 450 Fellows during the past year. A charge of 2*s.* per annum is now made for the postage of this Monthly Journal to subscribers of one guinea per annum; nor will this charge be deemed unreasonable when we bear in mind that the subscription, if diminished by the cost price and postage of the Journal, would leave but a very small remainder to meet the large annual expenses of the Society. It is also necessary to add that we receive about twice as much matter in the course of the year as was supplied under the late arrangements, and we have the very important additional advantage of a *monthly record* of valuable notices of foreign publications, as well as of the 'Proceedings' of many kindred societies at home and abroad. This *story of the Journal* cannot but be gratifying, and your Council feel that our thanks are due to the Editor and the Publisher for their ready conformity with all the Society's stipulations.

One remaining proposal I will venture to submit to you. It has received the unanimous approbation of the Council; and the personal support which several of its members offer, will, I hope, be appreciated and copied by other Fellows of our Society. I will state then, in few words, that the increased advantages which the Society is now able to offer as compared with earlier years induce me to hope that many Fellows will voluntarily raise their subscription. The guinea subscription is so nearly balanced by the copy of the Society's 'Transactions and Proceedings,' the expenses of the soirée, the rent and cost of circulars, &c., as to leave only a mere trifle for other purposes.

It would obviously be unfair to make any unexpected demand upon gentlemen to whom the low terms of subscription offered a chief inducement to join the Society, or in any way to press *them* for an advance; but now that the library, daily open for consultation, has been largely augmented by purchases and donations—the latter including a complete set of the 'Philosophical Transactions'—and when valuable and larger collections of instruments, apparatus, and objects are likewise accessible, it is believed that many Fellows who entered at 1*l.* 1*s.*, but who can well afford the outlay, will not grudge a further annual payment or donation, to be appropriated to the advancement of microscopical science.

It is felt that this appeal may be made to our original compounders as well as to our annual subscribers at the lower rate, and it is needless to add that a kind reception of this proposal would materially contribute to the well-being of our parent Society.

Such then, in conclusion, is our position and our work. We have gone on year after year, both gaining knowledge ourselves and communicating knowledge to others. Let us still be up and doing while the Great Architect of the Universe permits us to investigate His works, and "all His works praise Him." Let us never rest upon our oars, whilst, in the language of the immortal Newton, "the great ocean of truth lies all undiscovered before us."

Conspectus of the Present State of the Society :—

	Royal Patron.	Honorary and Foreign.	Associates.	Compounders.	£1. 1*s.* yearly.	£2. 2*s.* yearly.	Total.
Anniversary, 1869 ..	1	5	2	94	329	24	455
Since elected	..	+ 2	..	+ 1	..	+ 11	+ 14
Since deceased	..	− 1	..	..	− 4	..	− 5
Since resigned	..	..	..	..	− 5	− 1	− 6
Anniversary, 1870 ..	1	6	2	95	320	34	458

II.—OBITUARY NOTICE

Of the late JOSEPH JACKSON LISTER, F.R.S., Z.S., *with special reference to his Labours in the Improvement of the Achromatic Microscope.* Contributed, in a letter to the President of the Royal Microscopical Society, by JOSEPH LISTER, F.R.S., Professor of Clinical Surgery in the University of Edinburgh.

(Communicated by the PRESIDENT at the Anniversary, February 9, 1870.)

MY DEAR SIR, EDINBURGH, *8th February*, 1870.

In compliance with your request, I proceed to furnish you with some particulars regarding my late dear and honoured father.

He was born in London on the 11th of January, 1786, his parents being highly respected members of the Society of Friends. At fourteen years of age he left school to assist his father in the wine trade: but though he was for many years closely occupied in business, he contrived, by early rising and otherwise, to supplement largely the plain, though good, school education he had received, and he was in many respects a self-taught man. Such was the case as regards his mathematical knowledge, which he turned to such excellent account in his labours for the improvement of the microscope.

His predilection for optics manifested itself very early. He used to tell how, when a little child, he enjoyed looking at the prospect through air-bubbles in the window-pane, which improved the vision of the then myopic eye and enabled him to see distant objects with distinctness. This fact afterwards led him to think it probable that in very young children the eye is generally myopic. The same taste was indicated when he was a boy at school by the circumstance that he alone of all the boys possessed a telescope.

The achromatic microscope was early an object of interest to him; but it was not till the year 1824, when he was thirty-eight years old, that he did anything to improve the object-glass. His first work of this kind is recorded in a note, dated 1825, to the following effect:—"The $\frac{4}{10}$ and $\frac{2}{10}$ achromatic object-glasses, made by W. Tulley at Dr. Goring's suggestion, delighted me by their beautiful performance, but they appeared to me to have a great disadvantage in consequence of the thickness in proportion to their focal length, which W. T. thought could not be avoided. I therefore induced him to make for me one of $\frac{9}{10}$ much thinner in proportion, and had the satisfaction to find its performance *very nearly* equal to his best $\frac{2}{10}$. In one respect, indeed, it is superior; showing when in good adjustment the reflection from a minute ball of mercury a bright point in any part of the field, while in the

$\frac{2}{10}$ and $\frac{4}{10}$ it is so shown only in a small portion of the field near the centre, and in the rest has a bur shooting outwards." This bur, of which a sketch is given, is the first mention of the "coma" which afterwards formed so important a subject of his investigations. The note goes on to describe a suggestion for another combination, illustrated by drawings of magnified views of the curves of the glasses, executed with his usual extreme neatness and accuracy; and it concludes with the words "tried many experiments to ascertain the best means of correcting small errors in aberration."

The note from which these quotations are made is the first of a long series of accounts of experiments, with remarks upon them, indicating an amount of labour of which, as I never saw the papers before, and as the work was for the most part done either before my birth or during my early childhood, I had previously had no idea. The notes are beautifully arranged and might well be published just as he left them. I must, however, content myself with mentioning, in chronological order, some of the most interesting of their contents.

In 1826, after a description of Amici's reflecting microscope and an account of its performance, I find further projections of object-glasses for Mr. Tulley, followed by a drawing for the engraver to illustrate a description of Tulley's microscope, published by that optician. A copy of this pamphlet has been preserved, and the first page begins with this acknowledgment:—"Before commencing the description of the microscope it will be proper to state that the construction of the instrument and its apparatus was suggested and made from original drawings by my friend, J. J. Lister, Esq., whose ingenuity and skill in these matters are very generally acknowledged." The chief novelties in this instrument, besides the improved object-glasses, were the following:—

Graduated lengthening tube to the body. The stage-fitting for clamping and rotating the object. A subsidiary stage. A dark well. A large disc, which would incline and rotate for opaque objects. A ground-glass moderator. A glass trough. A live-box made with flat plate. A combination of lenses to act as condenser under the object (apparently the first approach to the present achromatic condenser). The erecting-glass; and the adaptation of Wollaston's camera lucida to the eye-piece.

The value of the erecting-glass for facilitating dissections under low powers is, perhaps, even yet not sufficiently appreciated.

The camera lucida had long been a favourite instrument with my father for drawing landscapes: and I may add that the tripod which he invented for supporting the drawing and the camera, is that which is now universally used by photographers.

In December of the same year occurs an account of an examination of a set of four plano-convex lenses, each consisting of a bi-convex of plate glass and a plano-concave of flint glass cemented to it by varnish, constructed by Chevalier, of Paris. Various interesting observations are here met with. He found that the maker had done injustice to his own instrument by shutting out a needlessly large portion of circumferential rays; and that when the apertures had been enlarged by increasing the holes in the stops, the glasses performed much better, so as to "give him strong doubts of the figure of these small achromatics being injured by varnish" (for in Tulley's glasses the constituents of the compound lenses were not cemented together), and he remarks on the great advantage that would be derived from cementing, if unobjectionable otherwise, in facilitating the manufacture.

He made various trials with these glasses in combination, and remarks:—"I will put down my trials of the glasses as they were made. Some of them have surprised me; and they will show, I think, remarkably, the advantage to science and art of collating the detached labours on the same subject, of distant individuals. The French optician knows nothing of the value of aperture, but he has shown us that fine performance is not confined to *triple* object-glasses" (Tulley's were triples); "and in successfully combining *two* achromatics he has given an important hint, probably without being himself acquainted with its worth, that I hope will lead to the acquisition of a *penetrating power* greater than could ever be reached with one alone." In the light of subsequent events this reads almost like a prophecy.

With respect to a combination of one of Chevalier's glasses with one of Tulley's, he writes:—"The performance of this compound is the finest I have ever seen produced by achromatic glasses, and furnishes, I think, a very important fact. Its virtual focus is ·52 inch, while W. Tulley's $\frac{3}{10}$ is but ·33 inch, and Chevalier's combination only ·26 inch; yet it goes beyond them both in clear positive power of defining."

But the most interesting parts of this note are those which record, for the first time, some puzzling appearances in combinations of compound lenses, which ultimately led him to his great discovery of the two aplanatic foci. Each of Chevalier's compound plano-convex lenses when used singly presented a bur or coma outwards, but when two of them were combined, this coma, instead of being exaggerated, as might have been expected, was "*less than with any single glass*," while the performance was in other respects satisfactory. "Observing the advantages resulting from this combination," he "tried some others," among the rest two of Tulley's triple glasses, each of which taken singly was of fine performance. But, instead of unmixed improvement resulting, we find it noted:—"*N.B.* Each glass *separately* shows a bright object all over the field without bur, and is *not far from being achromatic*. But, *combined*, the objects not in the centre have a strong bur INWARDS, the colour is much under-corrected, and the spherical aberration is not right."

In the following year we find similar anomalous appearances recorded. Thus, on one occasion, on using in combination a triple glass of Tulley's free from coma and otherwise excellent, and a double plano-convex in which, when used alone, the spherical aberration was rather under-corrected and an outward coma presented itself, the combination proved to have the spherical aberration rather over-corrected and showed an inward coma. Again, a bi-convex glass of Herschel's construction, consisting of a bi-convex of plate with a flint meniscus, when used alone with the flint surface foremost had little or no coma, but when combined with a triple $\frac{9}{10}$ free from coma, showed a "bur much inwards." The same glass used alone with the plate side foremost showed a "bur inwards," but when it was combined with the triple, which had before had the effect of inducing an inward coma, the bur inwards was changed to a "bur slightly outwards."

Such are samples of the perplexing and seemingly inconsistent observations recorded at this period. To a less accurate observer and a less acute mind they must have proved utterly bewildering. But he did not despair of finding an explanation of the appearances, and the last note on the subject in that year alludes to the angle formed by the rays of light with the concave lens as affecting the direction of the coma.

He was afterwards occupied for a while with planning triple glasses to be used in front of the previous triples of Tulley, and with general arrangements for the instrument. But, in November, 1829, a set of five plano-convex glasses manufactured by Utzschneider and Fraünhofer, very similar to those of Chevalier but uncemented, having been placed freely at his disposal by Mr. Robert Brown, the botanist, he set to work in good earnest to strive to solve the difficult problem. The experiments made with this object are recorded in a series of tables, the first of which gives an accurate description of each of the five new glasses and also of those of Chevalier, and of their performance when used singly. The others give the effects of various combinations of those glasses upon the chromatic and spherical aberrations and upon coma. He had previously observed, as mentioned in a note in 1827, that in a particular combination of two glasses, the coma was diminished by separating the glasses. And we find in these tables that the performance of each combination is given, both when the glasses are close and when they are separated a certain distance from each other. As we look down the tables we seem for a while to find confusion worse confounded. We see, indeed, abundant evidence of the great effect produced both upon coma and upon spherical aberration by the distance between the glasses; but the effects appear altogether inconsistent, if not contradictory. Thus, as regards coma, two of Fraünhofer's glasses which, if used singly, gave slight outward coma, gave when combined and near together a great deal of coma rather outward, but when separated by 1·2 inch an almost entire absence of coma, and what there was rather inwards. But, farther down, three glasses which each gave outward coma when single, are seen to present in combination an inward coma when close, and an outward coma when separated. With respect to spherical aberration we seem for a while to meet with something like a law. We find that two glasses which, if used alone, are free from spherical error, when combined and close have that error over-corrected, but this over-correction is removed by separating the glasses. And the same thing occurs with several other combinations. But looking down the table we come to a case where the excess of spherical correction caused by a combination of three glasses placed close, cannot be removed by separating them, and then follows a combination of three, in which "the excess of spherical correction is *increased* by separating for the short distance we can go." And, again, a little lower occurs a combination, also of three, in which "the excess of spherical correction is diminished but not conquered" by separation of the glasses.

Yet out of this apparent confusion he educed a principle which reconciled all the conflicting appearances, and formed the basis upon which all fine combinations for high powers of the microscope have rested. He found that in a plano-convex lens, constructed like those above described, in which a double convex of plate has its colour corrected for a moderate aperture by a plano-concave of flint, the effect of the flint lens upon the spherical error caused by the plate varies remarkably according to the distance of the luminous point from the glass. If the radiant is at a considerable distance, the rays proceeding from it have their spherical error under-corrected; but as the source of light is brought nearer to the glass, the flint lens produces greater proportionate effect, and the under-correction diminishes till at length a point is reached where it disappears entirely, the rays being all brought to one point at the conjugate focus of the lens. This, then, is an aplanatic focus. If the luminous point is brought still nearer to the glass, the influence of the flint lens continues for a while to increase, and the opposite condition, of over-correction, shows itself; but on still further approximation of the radiant, in consequence apparently of a reversal of the relations to each other of the angles at which the rays of light meet the different curves of the lens, the flint glass comes to operate with less effect, the excess of correction diminishes, and at a point somewhat nearer to the glass vanishes, and a second aplanatic focus appears, and from this point onwards under-correction takes the place of over-correction, and increases till the object touches the surface of the glass. Such a lens, then, has two aplanatic foci: for all points between these foci it is over-corrected, but under-corrected for points either nearer than the shorter or more distant than the longer focus. A knowledge of these facts enables the optician to combine a pair of such lenses with perfect security against spherical error. In order to do this, to quote from my father's paper in the 'Philosophical Transactions,' read January 21st, 1830, "the rays have only to be received by the front glass from its shorter aplanatic focus, and transmitted in the direction of the longer correct pencil of the other glass." The light then proceeding through each glass, as if from one of its aplanatic foci, is brought correctly to a focus by the combination. Supposing two glasses to have been so arranged, if the front glass is carried nearer to the back one, light proceeding from the shorter aplanatic focus of the front glass will reach the back glass as if from a point nearer than its longer aplanatic focus, that is to say, from a point between the foci, and therefore the spherical error will be over-corrected. On the other hand, separation of the glasses beyond their original interval produces under-correction. Thus, by merely varying the distance between two such lenses, the correction of the spherical error may be either increased or diminished at pleasure according to a definite rule, and slight defects in the glasses can be remedied by simply altering their relative position, the achromatism of the combination being meanwhile happily little affected.

Another beautiful circumstance connected with the aplanatic foci is that of their relation to the coma. At the shorter focus the coma is inwards, at the longer focus outwards; and in a combination of two lenses arranged as above described, the inward coma from the shorter focus of the front glass destroys the outward coma from the longer focus of back glass, and "the whole field is rendered beautifully flat and distinct."

The same principle applies when the lenses are of different form, and when more than two are combined. Thus the manufacture of the achromatic object-glass was reduced from a matter of uncertainty and empiricism to a scientific system, and has become susceptible of a degree of perfection that would otherwise have been impossible.

But though he had thus discovered the principle of construction, his own labours were far from being concluded. The next section of his notes is labelled "Memoranda on object-glasses made for experiment, Dec. 1829 to May 1830." These include a great number of interesting observations, such as trials of lenses of different forms; descriptions of the "colours of over, under, and right correction," as seen when the object is out of focus, illustrated by coloured sketches; experiments on the effects of varnish; proof that a compound lens has more effect on spherical and chromatic aberration when placed behind in a combination than when in front, &c.

Then follow a set of notes of peculiar interest, describing the effects of glasses made by his own hands. These are referred to in a letter to Sir John Herschel, of which he preserved a copy, together with Sir John Herschel's reply. The letter is dated London, 24th of 2nd month (Feb.), 1831. In it the following passages occur:—"Finding, however, that W. Tulley was too busy to pursue for me the experiments I wished for ascertaining how compound object-glasses could be combined to the greatest advantage, I determined in November last to make a trial myself. The result was, I acknowledge, beyond my expectations; for without having ever before cut brass or ground more than a single surface of a piece of glass, I managed to make the tools and to manufacture a combination of three double object-glasses, without spoiling a lens or altering a curve, which fulfilled all the conditions I had proposed for a pencil of 36 degrees." . . . . . "Long illness among my children afterwards absorbed all my leisure till about three weeks ago, when I made a second and more complicated trial, projected for obtaining the same effect with a much larger pencil. This is just finished, but not without altering one of the original curves; and its plan might be improved if I could spare time to make another set. Still I flatter myself these attempts would interest thee, as showing how easily the principle I mastered may enable an utter novice in glass-working to produce vision which I have not yet seen exceeded." In the second of these trials he deviated from the plano-convex form of the lenses, employing a combination of three, of which the front was a double meniscus, the middle a triple, and the back one a double plano-convex. The reasons for preferring these forms are given in full detail in his notes, among which occurs the ingenious idea of regarding the triple with the middle of flint glass as divided by an imaginary line through the flint into two double achromatic glasses, each of which may be considered separately as having two aplanatic foci. The object he proposed to himself was "a construction fitted to obtain the largest pencil with good front space and without coma;" and after describing the mode by which this was arrived at, he says, "This combination proves most satisfactorily the advantage of keeping the angles of the rays at all the different curves moderate, the vision being singularly definite and easy. . . . . . Indeed, taking all together, I think I have met with nothing to equal it—the distance of the front glass from the object being 0·11 full."

Having now completely satisfied himself of the applicability of his principle, he devoted much of his leisure for several years to various investigations by aid of the instrument which he had so greatly improved. Some of the results are well known to the public. Selections from his observations on zoophytes and ascidians, beautifully illustrated by sketches from life by the camera lucida, form a classical paper in the 'Philosophical Transactions.' But a laborious inquiry, chiefly conducted by means of the microscope, into the limits of human vision, as determined by the nature of light and of the eye, has never been published. He had at one time almost prepared an account of it for the press, when the illness of his eldest son, which ended fatally, threw such a cloud over his spirits that for several years he had not the heart to complete the work. And when at last he did resume it, and was on the eve of publication, he learned that the Astronomer Royal, Professor Airy, had reached the same conclusions, though by a different road, and so abandoned the idea, a circumstance in my opinion deeply to be regretted.

But to return from this digression. The next note in order of date regarding the construction of the microscope, is one made in 1837, headed "Remarks on A. Ross's suggestion for three glasses to admit a large pencil, which J. J. L. thought would not answer. A. R. tried it, and found it a failure, before trying J. J. L.'s suggestion below." Then follows a drawing of a proposed combination of three glasses "for the same object," giving the dimensions of the lenses and the curves of the various surfaces, with a statement of the effect proposed to be produced by each glass upon spherical aberration and coma. This resulted in Ross's celebrated $\frac{1}{8}$-inch object-glass, the construction of which was afterwards adopted by the other principal London makers.

A statement in his handwriting found among his papers gives, in a few words, his relations to the British microscope.

"I had been from early life fond of the compound microscope, but had not thought of improving its object-glass till about the year 1824, when I saw at W. Tulley's an achromatic combination made by him at Dr. Goring's suggestion, of two convex lenses of plate glass, with a concave of flint glass between them, on the plan of the telescopic objective. They were very thick and clumsy. I showed him this by a tracing with a camera lucida, which I had attached to my microscope, and the suggestions resulted in 'Tulley's $\frac{9}{10}$,' which became *the* microscopic object-glass of the time. But the subject continued to engage my thoughts, and resulted in the paper 'On the Improvement of Compound Microscopes,' read before the Royal Society, Jan. 21st, 1830, announcing the discovery of the existence of two aplanatic foci in a double achromatic object-glass. This has formed a basis for subsequent important improvements, the object of which has always been to obtain sharpness and achromatism over the field in the picture from a larger and larger pencil; this being an essential to obtaining higher and higher defining power.

"After succeeding fairly in a trial combination with this view, I left the subject for a while, hoping it would be pursued by opticians. But the glasses produced by the makers continued to be on the first simple construction of two or three plano-convex compound lenses till the beginning of 1837. At that time I called on Andrew Ross regarding some object-glasses he had made to a microscope for Richard Owen; when he told me he had been long engaged in unsuccessful trials for a new construction. And at his request I gave him a projection for a $\frac{1}{8}$-inch objective of three compound lenses, the front one a triple, which he soon worked out successfully, and it became the standard form for high power for many years.

"For lower powers I suggested at the same time a double combination, and, borrowing of him a lens from among his former failures, and applying it in front of one of my own at home, obtained at once the performance required.

"It was natural that A. Ross should regard these as trade secrets; and accordingly, in his article on the Microscope in the 'Penny Cyclopædia' he does not mention them, giving only the earlier construction of my article in the 'Transactions.' The same is given afterwards in the treatise which J. Quekett asked at the point of its publication to dedicate to me! And I did not feel required to disclose A. Ross's secrets. After a while, with his consent, I instructed James Smith, 1840, to execute the same construction for inch and half-inch glasses. Even in 1843 it was with the understanding that he should not go to deeper powers than $\frac{1}{4}$-inch, and 'Smith's quarters' were long in repute. In these projections the endeavour was to keep the angle of pencil at each surface of the glasses as moderate as was consistent with the other essentials; and by degrees the pencil admitted has been enlarged beyond my expectations. Some variations too have been since made in the construction in which I have had no part; but for all, the principle of the two aplanatic foci has furnished the clue."

I believe I am correct when I state that in foreign microscopes also, object-glasses of high powers and fine performance are constructed on the same principle. And thus it seems not too much to say, as has been lately said by a Professor in one of our Universities—the son of one who was formerly associated with my father through a common love of science—that he was "the pillar and source of all the microscopy of the age."

Although in this notice I have confined myself chiefly to matters connected with the microscope, it is right that I should add that these were far from forming the exclusive occupation of his leisure hours. The comprehensive grasp of his intellect and the extent and variety of his attainments were as remarkable as the accuracy and originality which characterized his microscopical work. Indeed there were few subjects in literature, science, or art with which he did not show himself more or less familiar. His clear, calm judgment and strict integrity made his opinion highly valued among his friends in matters of difficulty or dispute. He was most unselfish, and scrupulously tender of hurting the feelings of others, and extremely generous in the pecuniary support of public philanthropic objects, as well as in secret acts of charity. Though warmly attached to the religious Society of Friends, to which he belonged, he was a man of very liberal views and catholic sympathies. But the crowning grace of this beautiful character, though it might veil his rich gifts from those not intimate with him, was a most rare modesty and Christian humility.

Living to an advanced age, he retained his activity of body and mind to the last. But while to his friends this appeared remarkably the case, he was himself keenly alive to the gradual effects of years upon him, and his sensitive nature shrank from the idea of the helpless state to which he might be brought if his life should be prolonged like his father's, who lived to 98; and he often expressed the desire that he "might not outlive his powers." His wish was granted. He had only just returned from a stay at the sea-side, where he had enjoyed long rambles and excursions, when a feverish attack rapidly but almost painlessly prostrated his strength. Fully aware that his end was approaching, his loving interest in others was conspicuous to the last, while for himself he showed no anxiety, except the earnest desire for a speedy dismissal. He died at Upton House, in Essex, on the 24th of October, 1869, in the 84th year of his age.

Believe me,

My dear Sir,

Yours very sincerely,

JOSEPH LISTER.

To the Rev. J. B. READE, F.R.S., P.R.M.S.

III.—*On the Structure of the Stems of the Arborescent Lycopodiaceæ of the Coal-measures.* By W. Carruthers, F.L.S., F.G.S., Botanical Department, British Museum.

III. On the Nature of the Scars in the Stems of Ulodendron, Bothrodendron, and Megaphytum; with a Synopsis of the Species found in Britain.

(Communicated to the Royal Microscopical Society by the President.)

(*Continued from Vol. II., page* 227.)

These genera are founded on stems which have large scars in longitudinal series on the two opposite sides of the stems. Of one of these the authors of the 'Fossil Flora' (plate lxxx.) said, many years ago, that "of all the anomalous forms that the Coal-measures have afforded traces this is perhaps the most remarkable." The various and very opposite opinions which have been, and still are, entertained in regard to them fully justify this statement. For several years my attention has been directed to the group, and during that time I have lost no opportunity of examining specimens in different collections in Britain. I have, besides, carefully examined a large series—most probably the largest anywhere to be found—in the British Museum. The interpretation which I have been led to adopt is somewhat different from that of my predecessors, but before explaining it and the data on which it rests, it will be well to give an historical sketch of the different opinions hitherto entertained.

The earliest notice of these fossils with which I am acquainted is by Steinhauer, in the 'American Philosophical Transactions' (vol. i., New Series, 1818), where he gives a very accurate drawing and description of *U. parmatus*. He cautiously considers that there is not sufficient data to form any satisfactory idea of the affinities

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EXPLANATION OF PLATE XLIII.

Fig. 1.—*Ulodendron Taylori*, sp. nov. Natural size. From a specimen from Bathgate, Linlithgowshire; in the British Museum.

" 2.—*U. pumilum*, sp. nov. Natural size. From a specimen from the Yorkshire Coal-field, in the British Museum.

" 3.—*U. minus*, Lindl. and Hutt. Section of the inverted cone of an aërial root in a sandstone cast of the stem, showing the depth to which the articulating surface penetrated the stem. From the collection of Ch. Peach, Esq.

" 4.—*U. majus*, Lindl. and Hutt. Scar and leaves, natural size. From the cast of a specimen found near Swansea by Mr. Lucas; in the British Museum.

" 5.—*U. tumidum*, sp. nov. Stem reduced one-third, showing the arrangement of the vascular bundles for the leaves, some patches of the carbonized remains of the bases of the leaves, and the swollen bosses from which the aërial roots sprang.

" 6.—A patch of the carbonized remains of the bases of the leaves, natural size.

" 7.—A cicatrix, natural size.

of the fossil, although he refers to the "curious resemblance that it has to that of some *Jungermanniæ* preparing for fructification, when highly magnified." Steinhauer includes under the same specific name a fragment of the stem of a Calamite exhibiting the large round scars of several branches, with the small and linear scars of the whorls of leaves. A similar fragment was afterwards figured in Lindley and Hutton's 'Fossil Flora' (plate cxxx.) under the name of *Cyclocladia major*. The scars of *Calamites* and *Ulodendron*, as I hope presently to show, were produced by similar causes; and it is a singular testimony to the accurate observation and enlightened views of the reverend author, which characterize his important memoir, that he united two objects that are apparently so different.

Rhode, in 1820, published, in his incomplete 'Beiträge zur Pflanzenkunde der Vorwelt' (plates iii. and vii.), figures of two forms of *Ulodendron*, and though he did not apply names to them, he entered into a long investigation as to the nature of their scars. In one species (*Ulodendron parmatum*) he held them to be the remains of flowers; and in a somewhat restored drawing, twice the natural size, of one of these scars, he gives it the aspect of small-petaled, oval, water-lily. This is perhaps not to be wondered at in an author who found the coal shales covered with impressions of the most highly organized flowers, preserved as if they had been laid out by a palæozoic botanist for his herbarium. His plates are greater curiosities than his specimens, and do no little credit to the liveliness of his imagination. The scars of his second species (*U. minus*, plate viii., figs. 1–3), inasmuch as they did not present any traces of petals, he held to be the cicatrices of fallen leaves.

In 1823 Allan published* a figure of *U. parmatus*, from a finely-preserved cast found at Craigleith Quarry, near Edinburgh. The same specimen was subsequently figured by Buckland and by Brongniart, and I give on Plate XLIV., Fig. 4, a careful drawing of one of the scars. He did not venture on any decided opinion as to the nature of the scar.

Sternberg, in 1825, in the 'Tentamen Floræ Primordialis,' prefixed to his great 'Flora der Vorwelt,' gave the name of *Lepidodendron ornatissimum* to the first of Rhode's species, and, supposing that the scars resembled in some degree those on the trunk of arborescent ferns, he considered them to be the bases of leaves.

In 1831 Lindley and Hutton began the publication of their famous 'Fossil Flora,' and two of the early plates were dedicated to two specimens of *Ulodendron—viz.*, plate v., *U. majus*, and plate vi., *U. minus*. They held that the scars indicated points from which had fallen off branches, or more probably masses, of inflorescence, consisting of closely imbricated scales like the cone of

* 'Trans. Roy. Soc. Edin.,' vol. ix., p. 235, plate xiv.

Pinus. In their second volume they figured *Bothrodendron punctatum,* and the additional materials before them satisfied them that the cavities were the points of attachment of very large cones, which consisted of rounded polished scales three-tenths of an inch thick, attached to a central axis, and fitting accurately to each other. So completely did they resemble "such a strobilus as that of *Pinus Lambertiana,* that," say the authors, "we cannot doubt that the plant belonged to the natural order *Coniferæ.*" And to this opinion they adhered at the close of their serial publication, for in the letter-press to plate ccxviii., which they considered the same as *B. punctatum,* they say they have nothing to add to what they had already said.

Buckland, in 1836, figured what he believed to be five species of *Ulodendron,* referring them without hesitation to *Coniferæ,* and holding that the scars were the impressions of deciduous cones. In the centre of each scar there is a cavity indicating the place of attachment of the cone. The upper portion is marked with furrows, produced by pressure of the long radiating scales at the bottom of the cone. This pressure nearly obliterated the smaller rhomboidal scales of the bark in those parts where the furrows are deepest; on the lower portion of the scars the scales of the bark were but slightly modified by the pressure of the cones. The back scales under the cone have fallen off, and the surface exhibits small apertures or tubular cavities, through which vessels entered from beneath the bark scales into the trunk.

Presl, in 1838, in Sternberg's 'Flora' (p. 185), considered the scars to represent the bases of branches, and referred the genera *Ulodendron* and *Megaphytum* (which he thought scarcely deserved to be retained as separate genera) to *Lycopodiaceæ.*

In his 'Prodrome' (1828), Brongniart, following Sternberg, placed Rhode's plant in *Lepidodendron,* but in the fragment of the second volume of his great 'Histoire des Végét. Fossiles' (1837), he places the three genera included in the title of the

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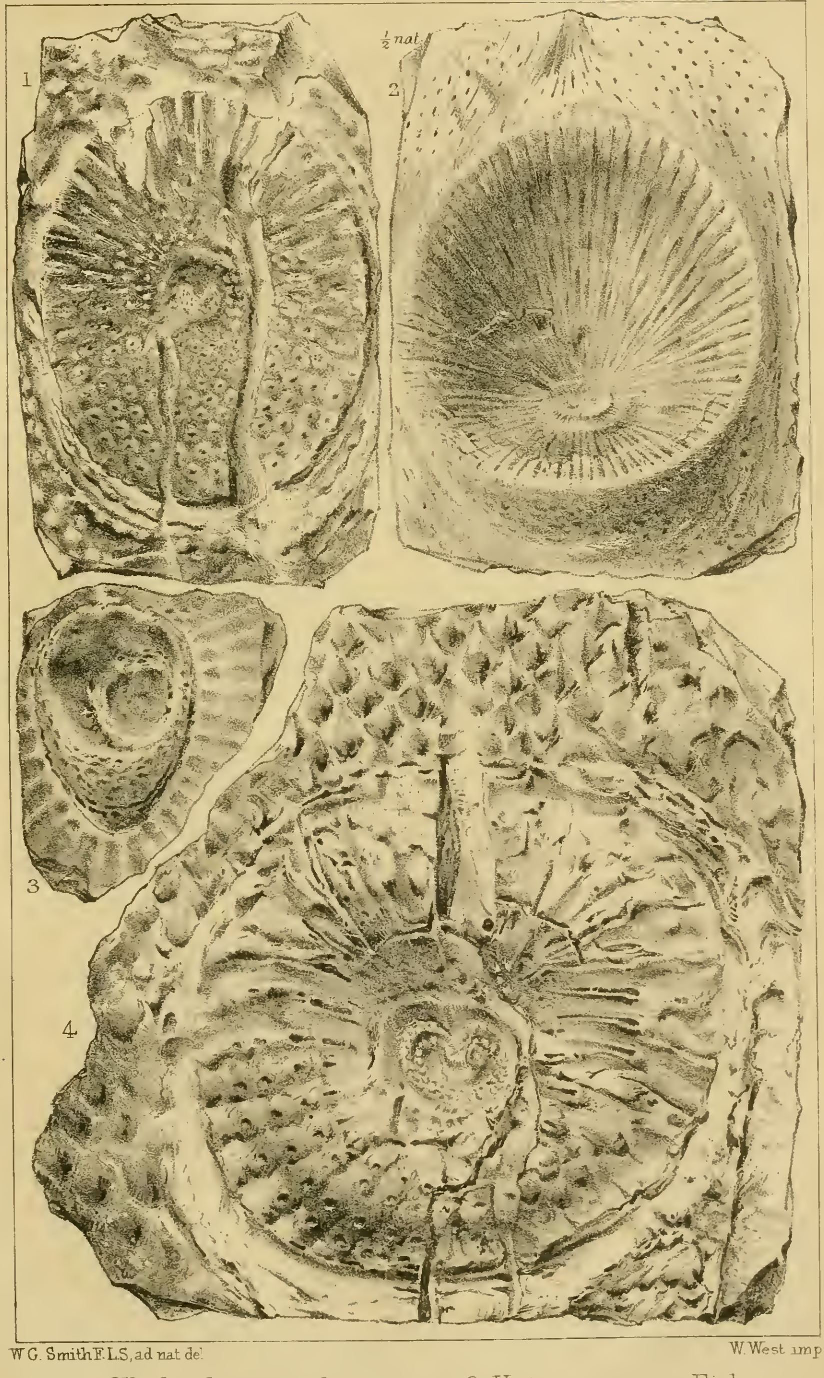
EXPLANATION OF PLATE XLIV.

FIG. 1.—*Ulodendron ovale,* sp. nov. Cicatrix of aërial root and leaf scars, natural size. From a specimen from the Edinburgh Coal-field, in the British Museum.

„ 2.—*U. transversum,* Eichw. Cicatrix of aërial root, and markings of the vascular bundles to the leaves, one-half the natural size. From a specimen from the South Wales Coal-field, in the Cardiff Museum.

„ 3.—*U. Stokesii,* Buckl. Scar of the compact bundle in the centre of the cicatrix of the aërial root. From a specimen from Halifax, in the British Museum.

„ 4.—*U. parmatum,* Carr. Cicatrix of the aërial root and leaf scars, natural size. From a cast taken from the natural sandstone cast; figured by Allan, and found at Craigleith, Edinburgh; now in the Museum of the Royal Society of Edinburgh.



W. G. Smith F. L. S. ad nat del. W. West imp.

Fig. 1. Ulodendron ovale, sp. nov. 2. U. transversum, Eichw.
3. U. Stokesii, Buckl. 4. U. parmatum, Carr.

present paper together in one group, considering that they probably differ only in the state of their preservation. He then enters into an investigation of the merits of Lindley's and Buckland's interpretation of the nature of the scar, and shows that the impressions on the under-half cannot be the scales of the stem, as they are arranged in a series peculiar to themselves, and different from that of the stem; and those on the upper part cannot be scars of cone scales, for they do not have the convex outer surface characteristic of all such scales. Unfortunately for the students of fossil botany, the 'Histoire' stopped at page 72, in the middle of a sentence, sufficient of which is printed to enable us to ascertain his critical objections to Buckland's views, but leaving untold his own interpretation of the nature of the scars. This loss is imperfectly remedied by the short note on the genus in his 'Tableaux des Germes Fossiles' (1849). Here he describes the scars as conical or hemispherical tubercles covered with foliar cicatrices, and prolonged in the centre into the beginning of a branch or adventitious root. His exposition is based on the beautiful specimen figured by Allan in the 'Edinburgh Transactions,' but he has overlooked the important fact that this specimen is a cast in sandstone of the outer surface of the stem, so that the elevated tubercles of the cast represented depressions in the original stem. He recognizes *Megaphytum* as a distinct genus allied to *Ulodendron*, and both forming a group near to *Lepidodendron*.

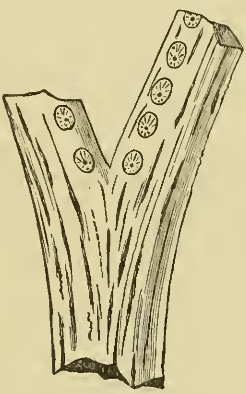
Göppert, in his 'Gattungen der Fossilen Pflanzen' (1841), figures a single scar, and considers it to belong to *Knorria*, and to represent in the central portion the point of attachment of a small branch, while the small scars are the bases of leaves arranged in relation to the branch—the interpretation afterwards given, as we have seen, by Brongniart.

Macalister, in a paper read to the Geological Society of Ireland (May, 1864), considered the fossil to be a cycadaceous plant, whose leaf scars were large and circular, and whose scales were as numerous and small as those of a Lycopod.

Dawson, in his 'Acadian Geology' (1868), refers *Ulodendron* and *Bothrodendron* to *Lomatophloios*, and says the scars "usually mark the insertion of the strobiles, though in barren stems they may also have produced branches; still the fact of my finding the strobiles *in situ* in one instance, the accurate resemblance which the scars bear to those left by the cones of the Red Pine when borne on thick branches, and the actual impressions of the radiating scales in some specimens, leave no doubt in my mind that they are usually the marks of cones; and the great size of the cones in *Lepidophloios* accords with the conclusion" (p. 456).

The genus *Megaphyton* he considers a tree fern, as the scars are not round and marked with radiating scales, but reniform or oval, like those of tree ferns, and so are more probably leaf scars; while the small linear scars would indicate ramenta or small aërial roots. He accordingly restores it as an arborescent form bearing two large fronds, one on either side of the stem (p. 448).

The scar differs somewhat in form, being in some species circular, but in the majority more or less oval. It is always in the form of an inverted cone, though from the great pressure to which the stems have been subjected it is generally flattened. The actual depth is shown in a specimen of *U. minus*, found by Mr. C. Peach at Redhall Quarry, near Edinburgh, which is an amorphous cast in white sandstone of the outer surface of the stem. One of the pits of the natural size is represented in Plate XLIII., Fig. 3. The base or centre of the pit presents a scar of different form in the different species. In *U. parmatum* it has a double horse-shoe shape; in *U. Stokesii* it is a half-oval; in *U. Taylori* it is circular; and so on. The figure is formed by a number of small pits representing the number and position of the vascular cords which supplied the supported organ. The remainder of the scar is covered with single pits, or radiating furrows arranged in symmetrical order around the basal scar. The pits are confined to the lower half of the scar, and the furrows to the upper half. That this is their true position has been already determined by the direction of the leaves when present, and by the form of their scars when they have fallen. I was enabled to establish it still more from the examination of an interesting dichotomously dividing stem in the collection of Daniel Ross, Esq., of Rockville, near Edinburgh, in which the position of the scars to the direction of the stem was clearly seen. There is not the slightest indication of scales in any of the large series of specimens I have examined. In attempting to make obvious what authors believed to be there, the drawings of *Ulodendron* frequently exhibit scale markings. Take, for example, the drawings of Allan's specimen of *U. parmatum* preserved in the Museum of the Royal Society of Edinburgh. The original drawing by Allan, though rude and turned upside down, is more accurate than Buckland's greatly reduced drawing * made from a plaster cast; or even than the original drawing by Brongniart, in his 'Hist. Vég. Foss.,' vol. ii., plate xxviii. In addition to examining the original specimen



Dichotomously divided Stem of *Ulodendron parmatum.*

* 'Geol. and Min.,' pl. lvi., fig. 3.

with great care, I took a cast of the whole of it, and several casts of the separate scars. From them the drawing of the scar on Plate XLIII., Fig. 4, has been faithfully produced by Mr. Smith. The original is a natural cast of the outer surface of the stem, whereas Mr. Smith's drawing is from the artificial cast, and consequently exhibits the true aspect of the outer surface of the scar. As is obvious, there are no scales; but the markings are all produced either by circular pits or by elongated furrows. These are the ends of the vascular bundles, as was determined by Presl and Göppert. The scar is bounded by a distinct boundary line, generally forming a raised margin, as in *U. parmatum.* This is certainly the boundary of the articulating surface, and shows that the smaller scars scattered over the large cicatrix were not the bases of leaves, as supposed by Göppert and Brongniart, but the bundles passing into a branch of some kind, as Presl suggested.

The difference in the form of the scars on the upper and under half of the stem which has puzzled observers, and has not yet been explained, will be obvious if we consider the structure of the stem on which these appendages were borne, as figured and described by me in former numbers of this Journal. On Plate XXXI.* was figured the structure of the axis and vascular cylinder of *U. minus.* A comparison of this drawing with that of *Lepidodendron selaginoides* on Plate XXVII. shows that the tissues of *Ulodendron* agree with those of *Lepidodendron* as far as they can be compared—and remembering that externally the two genera agree except in the possession of large scars by *Ulodendron*—there can be no doubt that the elementary tissues of the one stem can be supplied from the more perfect specimen of the other. It thus appears that the conical scar has passed far into, if not quite through, the regularly arranged prosenchyma of the circumference. The vascular bundles, rising upwards and outwards from the circumference of the vascular cylinder, would, in passing into the appendicular organ, penetrate the lower half of the articulating surface at right angles, and would consequently show as circular pits on the cicatrix; while the bundles on the upper half would penetrate the surface at a very oblique angle, and would consequently show on the cicatrix as more or less elongated furrows. This will be apparent by an examination of the accompanying diagram. In species, like *U. transversum*, where the inverted cone of the scar has a de-

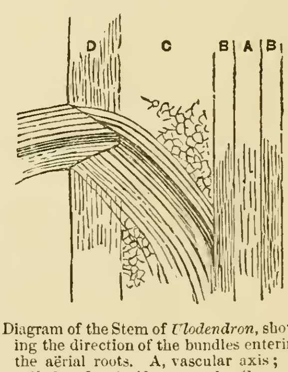


Diagram of the Stem of *Ulodendron*, showing the direction of the bundles entering the aërial roots. A, vascular axis; B, cylinder of scalariform vessels; C, parenchyma; D, prosenchyma.

* 'Monthly Microscopical Journal,' vol. i.

scending direction, the smaller will necessarily have a more or less furrowed aspect on the lower as well as on the upper half of the great scar.

It is remarkable that among the many specimens of *Ulodendron* that have been seen, none have exhibited the appendicular organ in its natural relation to the stem. Dr. Hooker says, Mr. Dawes showed him a specimen preserved in sandstone, with a large organ, which he considered to be a cone inserted into one of the cup-shaped depressions; but he was unable to form any conclusion concerning its real nature.* Had Principal Dawson rested his determination that scars were the impressions of the bases of cones on his having found one *in situ,* I must have concluded that his plant was very different from the European *Ulodendron;* but his illustration † agrees with the scars we have figured and described. We hope that a re-examination of the matter in the light of the additional facts and explanations contained in this paper, may lead the learned author to a different interpretation of the structure.

That the appendages were articulated to the stem by the whole surface of the scar cannot be doubted. In the want, however, of any observed specimen, it is not so easy to determine what these appendages were. The specimen figured on Plate XLIII., Fig. 5, appears to me to throw considerable light on the matter. In this species the opposite series of scars are borne on swellings on the stem, and the downward aspect of the scars shows that the organs which sprang from them had a descending direction. That this is the true position of the stem is abundantly established by the dark carbonaceous patches which here and there are attached to it, and which are the bases of the leaves converted into coal. One of these patches from the other side of the stem from that shown in the drawing is represented the size of nature at Fig. 6, and here it is seen that the bases of the leaves still remaining are imbricated over each other, and that the scars where the leaves were broken off are on the upper portion of each base. This clearly shows the natural direction of the specimen figured. The appendages, then, must have been adventitious roots in this specimen. In the light of this specimen, the form and direction of the scars where their original depth is to any extent preserved, appear to corroborate this view. The appendage could not in any of them have been patent; indeed, they seem to show that it must have passed out outwards and downwards.

The scars are not at all constant in the method of their arrangement. In *U. parmatum* I have seen a considerable fragment of the stem with only one well-formed scar upon it, the remainder being covered with rhomboidal leaf scars; in other specimens I have observed from eight to twelve scars, so closely approximated in

* 'Memoirs Geol. Surv. Great Brit.,' vol. ii., pl. ii., p. 427.
† 'Acadian Geology,' p. 457, fig. 170.

linear series that their adjoining margins touched, while in the bifurcated specimen figured on page 148, the lower and older portion is seen to be destitute of them, yet they appear on the two branches.

We know nothing of the upper portion of *Ulodendron.* It is very probable that the stems were repeatedly divided in a dichotomous manner, and that the branches, foliage, and fruit agree so nearly with those of *Lepidodendron,* that they have been referred to that genus. Hugh Miller, in an interesting paper "On some Fossils from the Edinburgh Coal-field," read to the Royal Physical Society, describes a specimen which, as it lay in the rock, exhibited a true branch shooting out at an acute angle from the stem, intermediate between the rows of scars. Unfortunately, the specimen was somewhat injured in lifting it from its matrix. It forms part of the Miller Collection now deposited in the Edinburgh Museum. On examination, I found that the leaf scars of the branch were arranged in a direction opposite to those on the stem, but this may have arisen from the fractured specimen having been incorrectly united.

Bothrodendron is universally referred now to *Ulodendron.* It was based upon a specimen from which the leaf bases and the outer portion of the stem (*f*, *g*, *h*, of Fig. 1, Plate XXVII.) had been removed, and instead of the more or less rhomboidal scars, the pits of the vascular bundles only are seen.

Megaphytum is based upon casts of the interior of the stem against the inner surface of the regular prosenchyma of the stem (*e*, of Fig. 1, Plate XXVII.). The scar represents only the main central vascular bundle of the scar of *Ulodendron,* and has the same form in the different species as in the species of that genus. Thus *M. distans* agrees with *U. Stokesii,* and *M. approximatum* with *U. parmatum.* The interrupted striæ which cover the stem between the rows of scars are the impressions of the meshes in the prosenchyma, through which the vascular bundles passed to the leaves. This view of these points is further established by the figure of *Megaphytum approximatum* given by Lindley and Hutton, 'Fossil Flora' (plate cxvi.). In this plate a more external portion of the stem is seen on the upper left-hand corner of the specimen; and this shows the regularly-arranged dots characteristic of the condition to which these authors gave the name *Bothrodendron.*

Megaphytum is related in the same way to *Bothrodendron* and *Ulodendron,* as *Knorria* is to the "decorticated" and "corticated" forms of *Lepidodendron,* and as the fluted casts of *Calamites* are to the smoother "corticated" forms.

Synopsis of the British Species.

Nat. Ord. *Lycopodiaceæ.*

Ulodendron, Lindl. and Hutt., 'Fossil Flora,' plate v. Stem covered with rhomboidal scars of leaves, and having large round or oval conical depressions arranged in linear series on opposite sides, from which sprang aërial roots; leaves acuminate, with a median nerve. *Megaphyton*, Artis, 'Antediluvian Phytology,' p. 20. *Bothrodendron*, Lindl. and Hutt., l. c., plate lxxx.

1. *U. parmatus*, Carr. Large cicatrix oval, 3½ inches long by 2½ inches broad; central scar of the form of a double horse-shoe; leaf scars elongated-rhomboidal. *Phytolithus parmatus*, Steinh., 'Amer. Phil. Trans.,' vol. i., Ser. 2, p. 287, plate vii., fig. 1 (1818). *Lepidodendron ornatissimum*, Sternb., 'Flora Vorw.'—Tent., p. xii. (1825). *U. Allanii*, Buckl., 'Geol. and Miner.,' vol. xi., p. 92, plate lvi., fig. 3 (1836). *U. Rhodii*, Buckl., l. c., p. 93. *U. Conybearii*, Buckl., l. c., p. 94, plate lvi., fig. 6. *U. Rhodianum*, Presl, in Sternb., 'Flora,' p. 186 (1838). *U. ellipticum*, Presl, l. c., *Bothrodendron punctatum*. Lindl. and Hutt., plate ccxviii. (non lxxx. and lxxxi.). *Megaphytum approximatum*, Lindl. and Hutt., plate cxvi.

A scar of an aërial root and of some leaves is shown, natural size, on Plate XLIV., Fig. 4.

From the Coal-measures, Edinburgh, Newcastle, &c. [Edin. Roy. Soc. Museum, British Museum, &c.]

2. *U. Stokesii*, Buckl., 'Geol. and Miner.,' vol. ii., p. 93, plate lvi., fig. 5. Large cicatrix, shortly oval, or sub or bicular, 4½ inches long by 3½ broad; scar of the small vascular bundles somewhat elongated and radiating; of the central bundle, semi-ovate, very broad at the apex, with a free space in the centre; leaf scars elongated-rhomboidal. *Megaphytum distans*, Lindl. and Hutt., 'Fossil Flora,' plate cxvii. *M. Allanii*, Brongn., 'Hist. Végét. Foss.,' vol. ii., plate xxviii, fig. 5, most probably belongs to this species. The original of his figure is in the Museum of the Royal Society, Edinburgh.

A figure of the scar of the central vascular bundle is given of the natural size in Fig. 3, Plate XLIV.

From the Coal-measures, Newcastle. [British Museum.]

3. *U. ovale*, sp. nov. (Plate XLIV., Fig. 1). Cicatrices oval, 2¼ inches long by 1¾ inch broad; scar of the compact bundle in the centre small, roundish, slightly indented on the upper margin; scars of the separate bundles very numerous; depressed margin of the cicatrix with a single series of vascular bundles; leaf scars rhomboidal.

From the Coal-measures, Edinburgh. [British Museum.]

4. *U. pumilum*, sp. nov. (Plate XLIII., Fig. 2). Cicatrices oval, nine lines long by seven lines broad; scar of the central bundle roundish, nearly central; leaf scars crowded, and covering the stem, broadly rhomboidal, with a central depression marking the place of the vascular bundle.

From the Coal-measures, Yorkshire. [British Museum.]

5. *U. Taylori*, sp. nov. (Plate XLIII., Fig. 1). Cicatrices oval,

nine lines long by eight lines broad; scar of the compact bundle roundish; separate scars fewer than in *U. pumilum;* leaf scars distant from each other, with as much free space separating them as their own breadth, obovate, with decurrent base, and a scar, where the vascular bundle passed out.

I have associated with this species the name of an old class-fellow, Andrew Taylor, Esq., Edinburgh, who during the past summer led me to a quarry in the neighbourhood of Bathgate, where he observed remains of *Ulodendra,* and where we succeeded in obtaining specimens of this interesting species.

From the Coal-measures, Linlithgowshire. [British Museum.]

6. *U. transversum,* Eichwald, 'Lethæa Rossica,' vol. i., p. 139, plate ix. Cicatrices deltoid, with the angles rounded, nearly 4 inches long by $3\frac{3}{4}$ inches broad; scar of compact bundle near the base, of a flattened horse-shoe shape, separate bundles radiating all round from the cone of the aërial root descending into the stem; leaf scars rhomboidal. *Megaphytum majus,* Presl, Sternb., 'Flora,' p. 187, plate xlvi., probably belongs to this species.

A scar half the natural size is figured on Plate XLIV., Fig. 2. It belongs to a "corticated" specimen, and shows only the pits of the vascular bundles belonging to the leaves.

From the Coal-measures, Northumberland (Jarrow) [British Museum], and South Wales [Cardiff Museum].

7. *U. majus,* Lindl. and Hutt., 'Fossil Flora,' plate v. Cicatrices circular, $2\frac{1}{4}$ inches in diameter; scar of compact bundles central, compressed circular; scars of separate bundles more or less pit-like throughout; leaf scars rhomboidal. *U. Lucasii,* Buckl., 'Geol. and Miner.,' vol. ii., p. 93, plate lvi., fig. 4 (1836). *U. Lindleyanum,* Presl, in Sternb., 'Flora,' p. 185 (1838). *Bothrodendron punctatum,* Lindl. and Hutt., 'Fossil Flora,' plates lxxx., lxxxi. (excl. plate ccxviii.).

The scar figured, Plate XLIII., Fig. 4, is from a fine cast of a specimen found near Swansea by Mr. Lucas.

From the Coal-measures, South Wales, Northumberland, &c. [British Museum.]

8. *U. minus,* Lindl. and Hutt., 'Fossil Flora,' plate vi. (excl. synonymes). Cicatrices sub-circular, from $1\frac{1}{2}$ to $1\frac{1}{4}$ inch in diameter; scar of compact bundles triangular with the angles rounded; scars of the separate bundles pit-like on the under half, radiating and furrowed on the upper; leaf scars rhomboidal.

The drawings by Lindley and Hutton of the last two species are very unsatisfactory. I have never seen the cicatrices composed of large flat scales, as represented there.

From the Coal-measures, Northumberland, Edinburgh, South Wales, &c. [British Museum.]

9. *U. tumidum*, sp. nov. (Plate XLIII., Figs. 5–7). Cicatrices small, oval, eight lines long by six lines broad, borne on tumid swellings on the opposite sides of the stem; solitary cicatrices scattered over the stem; scar of the compact bundle circular, of the separate bundles pit-like; few in number; leaves with a broad base imbricated.

Fig. 5 represents a portion of the specimen one-third the natural size; it has lost all indications of the bases of the leaves, except on one or two patches, one of which, from the surface not shown in the figure, is represented natural size at Fig. 6; and one of the cicatrices, natural size, in Fig. 7.

From the Coal-measures. Britain—locality unknown. [British Museum.]

IV.—*The Mode of Examining the Microscopic Structure of Plants.* By W. R. M'Nab, M.D. Edin.

II.

Having now considered the Cell-wall, we have next to take up the subject of the Protoplasm, Nucleus, and Cell-sap. The Protoplasm is a mixture of albuminous materials with water, and a small quantity of incombustible matter. In the young and active state of the cell, the whole of the cavity is filled up with the protoplasm. Mixed with the protoplasm we have various organic materials, as oils, starch, &c., which often increase to a very great extent, or else disappear altogether, leaving the cell-wall empty. The quantity of water in the protoplasm seems to vary, and as a consequence we find that the consistence of the protoplasm also varies, being sometimes very fluid. Imbedded in the protoplasm, and always in relation to it, we find the more solid protoplasmic body, the nucleus. The presence of a nucleus is not constant, as we sometimes have cells without one, either the cells never having formed one, or the nucleus after having been formed being dissolved in the general mass of protoplasm, and thus disappearing. In *Chara* we find that as the circulation in the cells begins the nucleus disappears. Besides forming the nucleus, the protoplasm seems intimately connected with the formation of chlorophyll and starch. The protoplasm is capable at certain times of moving. These movements are either slow or rapid, and three distinct kinds of movements have been described. In the remarkable conditions of that peculiar group of Fungi, the *Myxomycetes*, we have the external form of the masses of protoplasm constantly changing. Again, in some zoospores we find that the whole mass of protoplasm moves freely about by means of the peculiar cilia with which they are provided. Lastly, we observe streams of moving particles in the protoplasm of certain cells as in Vallisneria and Anacharis. In general the protoplasm is granular, but in the cotyledons of the Jerusalem Artichoke it seems to be homogenous, and to contain very little water. In Vallisneria it is very watery, and contains very few granules, while in many spores the protoplasm is so loaded with colouring matter and granules that no fluid basis can be detected. This diminution of the fluid basis may go to such an extent that we may have the protoplasm appearing in rounded granular masses with starch grains lying between the masses, as in the cotyledons of the Common Pea.

The *Nucleus* is frequently absent in certain Thallophytes, but is present as a rule in vascular plants and mosses. The nucleus generally assumes its full size at once, and in young cells seems to be quite out of proportion to the rest of the cell. In young cells, then, it occupies nearly the whole space of the cell, while in large older cells it takes up but a very small part of the cavity. In the young hairs of the *Hyoscyamus niger*, a further development of the nucleus has been observed. A firm outer layer forms, and drops of fluid accumulate in the nucleus, the granules then exhibiting a regular series of movements.

Chlorophyll being a substance always found in relation to the protoplasm must be here briefly noticed. The green colouring matter seems to be carried by granules of protoplasm, the protoplasmic base remaining colourless after the colouring matter is removed by alcohol or ether. The granules of chlorophyll always lie in relation to the protoplasm, in this resembling the nucleus, and are never found free or in the cell-sap. In some cases, as in zoospores, &c., the chlorophyll seems to form part of the protoplasm, and is not separated in the form of granules. In Zynema we have peculiarly shaped figures of green protoplasm, while in the vast majority of plants the grains are rounded. In size the granules vary greatly, being very large in Selaginellas. Starch and oil are also frequently found in the chlorophyll granules.

Other bodies are also found in relation to the protoplasm, as the *crystalloids* of Naegeli. They are portions of protoplasm which assume a crystalline form, with plane surfaces and sharp angles and faces. They occur in the forms of cubes, tetrahedra, octahedra, &c., in various plants, are of very minute size, and the angles seem to be inconstant. The crystalloids of the Potato were discovered by Cohn, and are to be found in the cells of the parenchyma, under the rind, which do not contain much starch. They are in general cubical, and sometimes occur in large quantities. Radlkofer discovered them in *Lathræa squamaria*. They are often in numbers inside the nucleus, and their general form is that of thin square plates, sometimes rhombic. Crystalloids have also been described as occurring in the aleuron grains of fatty seeds, as Ricinus, which are brought into view by dissolving the fatty matter by means of ether. Coloured crystalloids are described by Naegeli as occurring in the petals of *Viola tricolor*, *Orchis*, &c. The aleuron grains, so called by Hartig, are rounded granular formations found in ripe seeds: as the grains are altered by the action of water it is difficult to examine them.

Starch is another substance always found in the protoplasm; the granules increase in size as long as the protoplasm remains in the cell, but when it disappears the starch grains mix with the cell-sap, and all growth stops. The grains present well-marked differences in appearance, some of the grains being very characteristic.

The Cell-sap.—By cell-sap we mean the fluid contained in the vacuoles of the protoplasm. It seems to be essential to the growth of the cell, and contains many substances in solution. We may have organic acids, mineral salts, alkaloids, &c., dissolved in the cell-sap, and invisible; but frequently we have colouring matters, oil, or crystals in the cell-sap. Raphides seem also to be products of the cell-sap, as well as other substances, such as sugar. The last stage in the life of the cell is the disappearance of all the contents, and nothing remains but the dry cell-wall, more or less modified to adapt it to the position it occupies in the plant and the function it has to perform.

Let us now pass to the consideration of the tissues. We may consider a tissue as any aggregation of cells governed by the same laws of growth. In general we have the tissue formed by the repeated division of the mother-cell at the growing part of the plant; but in a few rare instances we may have cells originally free becoming fused together to form a tissue. This is seen in certain of the Algæ, as Pediastrum, Hydrodictyon, &c. When the walls of the cells forming a tissue are examined, we see but a single plate or lamella. This is well seen in the young growing cells at the point of the root, as in the White Mustard. When the cells become older and thickening occurs, then it is found to be deposited on each side of this lamella, in the inside of the wall of the cells. When thickening has thus taken place, the appearance becomes very deceptive, and we might think that the thickening layers were the true cell-walls, while the central lamella was a layer of intercellular substance. By a careful use of reagents we can separate these two elements, the lamella being soluble in sulphuric acid, while the thickening deposits can with care be dissolved in chlorate of potash and nitric acid. When the thickening deposits have been dissolved we can isolate the delicate lamella or cell-wall. The so-called intercellular substance, so well seen in many of the Algæ, is a gelatinous degeneration of the lamella. The lamella thus becomes greatly thickened, and the masses of thickening matter inside the cells become widely separated from each other. In tissues in which rapid growth takes place, we often find that numerous splits take place in the lamella. These splits form generally at those parts where the walls of contiguous cells join, or at other times the splitting is regular, the cells becoming altered in shape until we have star-shaped cells formed, as in the pith of the Rush and petiole of Banana. This process of splitting of the lamella may go on until the cells are isolated completely, as seen in many ripe fruits. It is by this splitting process that we have the intercellular spaces, resin-canals, stomata, &c., formed.

The tissues of a plant may be similar or dissimilar. We may have a single cell performing all the functions of plant life. Higher up we have a tissue composed of rows of cells, as in many of the lower Algæ; while in the higher plants we have numerous different kinds of cells grouped together in various ways. We can at first distinguish three layers of tissue in the highest plants: the external or limitary tissue, the fibro-vascular bundles, and lastly the cellular mass filling up the intervening space, the primitive tissue of Sachs. As growth goes on, these three systems become more complex, and different kinds of cells are formed in each. The chief forms of cells entering into the composition of all plants are:—1st, thin-walled cells, the length not greatly exceeding the breadth, and having intercellular spaces—Parenchyma; and, 2nd, cells placed in rows, generally considerably elongated, with overlapping ends, no intercellular spaces, and often greatly thickened—Prosenchyma. Both of these kinds of tissue may become hardened, as seen in the sclerenchyma developed in cork, fruits (as the pear), &c. This hardening is, however, only a physiological change in the condition of the cells.

Naegeli considers all cells as either being capable of dividing or not. The first he calls *Meristem*, the second *permanent tissue*. The cells out of which all the parts are formed in the root, stem, &c., Naegeli called *primitive meristem*, while the cambium cells which are only found in a certain locality he denominated *secondary meristem.*

Limitary Tissues.—These are only developed in plants composed of many cells. They form a protection to the plant, and are best developed in parts exposed to air and light, less so in those underground or in water. The cells of which the limitary tissues are composed are generally of small size, and the walls are strong and thick. In higher plants we have a layer which is in general easily separable from the others, the Epidermis. Beneath the epidermis we have the subepidermal tissue, or collenchyma. This is well seen in the Begonia, and it is peculiar in having masses of thickening formed at the corners. Cork is also developed in the more permanent limitary tissues of the higher plants. The epidermis disappears, and the cork is formed by the late-formed cells of the epidermis. The formation of the cork layer can be well seen in young shoots of the Black Currant. The epidermis is a unicellular layer; but in a few plants, as the Begonia, we have two, the second being formed by the division of the first into two. In the cells of the epidermis we do not find intercellular spaces, the stomata furnishing the means of communication with the subjacent tissues. Stomata may be absent, as in roots and submerged parts of plants. The external cell-wall of the epidermis is in general greatly thickened, forming what is called the cuticle. The cuticle is a continuous layer, often very largely developed and affording a considerable amount of protection to the more delicate tissues below. The various epidermal appendages must also be examined along with the limitary tissues. Hairs are developed by the epidermal cells, the hair appearing as a projection of one part of the cell. Hairs are variable in form. Root hairs are to be found in Marchantia, Equisetum, &c.; woolly hairs, either temporary, as in the bud of the Horse-chestnut, or permanent, as in certain species of Stachys, &c. Jointed or beaded hairs in Tradescantia, the branching hairs of Verbascum, Turnip, &c., stinging hairs, as in Nettle, Loasa, &c., which generally contain silica, are familiar objects. Glandular hairs, as in Rose, and scales, as in Sea-buckthorn, &c., are also to be considered as part of the limitary tissues. Stinging hairs are generally placed on an elevated portion of the epidermis. The scales of ferns seem to be modified hairs, the contents of the cells rapidly disappearing, and the hair becoming dry and chaff-like. The prickles of the rose are modified hairs, and seem to be developed by the glandular hairs. The stomata of plants form an endless variety of objects for the microscope. In general, they are developed from single epidermal cells. In the Marchantia several cells enter into their construction, while in a fern, *Anemia*, the stoma is developed in the centre of an epidermal cell. Besides the collenchyma, cork must also be considered as one of the limitary tissues. Cork forms a protecting covering, and also is of great importance in the healing of wounds in plants. The cork cells are developed from the so-called cork cambium. In large plants and trees we find three stages of the limitary tissues, each of which requires to be studied. On the youngest twigs we have a true epidermis; farther down we have the corky layer, the periderm, formed; while still farther from the growing point we have the bark. The last point that calls for mention in regard to the limitary tissues is the peculiar corky deposits called *Lenticels*. They are common on Willows, and have been described as glands. They, however, seem to be little masses of cork cells, and do not possess any secreting structure.

Fibro-vascular bundles.—In the tissues of all plants with true roots we find string-like masses of tissue permeating in every direction, and forming a more or less complete skeleton. These are the fibro-vascular bundles. Sometimes they are very easily separated from the tissues in which they are imbedded, as in Plantago, while in others they can only be separated with great difficulty. In many fruits and stems the delicate cellular tissue disappears, or dries up, and a number of string-like fibro-vascular bundles are left. In Myriophyllum the bundles are softer than the surrounding tissues, and apparently cannot be isolated. The bundles are often separated; but in some stems, as in those of Conifers and Dicotyledons, the bundles are compressed together in such a manner that the separate bundles of which the entire mass is composed are no longer distinguishable. Each of the fibro-vascular bundles consists of various different forms of tissue, forming a system running through the entire plant. At first the bundles consist of masses of similar cells, with no intercellular spaces. This tissue has been called the Procambium. As the procambium grows older, then the cells become more or less modified, and converted into the various permanent forms of cells, vessels, bast, &c., that we find in the perfect bundle. It frequently happens that the whole of the procambium is converted gradually into permanent tissue; but at times an inner layer of the procambium remains active, forming the cambium layer. In some plants we have the fibro-vascular bundles containing cambium, while in others there is no cambium. The bundles containing cambium are open or indefinite; those containing no cambium are closed or definite bundles. Closed bundles are to be met with in the Cryptogams, Monocotyledons, and many Dicotyledons, and are incapable of growth beyond a certain size. Open bundles, on the other hand, are to be met with in the roots and stems of Dicotyledons and Conifers, and are capable of growth for an indefinite period. In the leaves of Conifers and Dicotyledons we generally find closed bundles; but if they are open, then their activity soon ceases, and growth stops. Naegeli has divided the tissues of the vascular bundles into two groups. These are separated by the cambium, and are named *Phloem* and *Xylem;* the Xylem part being the wood proper, while the Phloem is in general considered as part of the bark. It is, however, developed as part of the vascular bundle, distinct from the limitary and primitive tissues. The cells in the Phloem part of the fibro-vascular bundle are thin-walled sap-bearing cells and the thickened bast-cells, while the Xylem consists of cells which have become thickened and woody. Sometimes, as in the Raddish, Potato, &c., the cells of the Xylem do not become woody, but remain thin-walled and parenchymatous. The medullary rays belong to both the Phloem and Xylem part of the bundle. The structure of the fibro-vascular bundles is not difficult to examine, and many forms of cells and vessels enter into their construction, rendering them interesting objects of study.

We have now to say a few words on the tissues which remain after the limitary and fibro-vascular tissues are developed. This mass of cells, part of Naegeli's primitive meristem, Sachs has designated Primitive Tissue. Sometimes a considerable quantity of parenchyma is left unaltered, while at other times it can hardly be detected. As, however, in the young state of the stem the primitive tissue can be distinctly seen surrounding the fibro-vascular bundle, and serving, as it were, as a kind of packing, it seems advisable to retain it as a separate tissue.

The last group of tissues which we have to consider belong to none of the three groups already considered, but while differing from each other morphologically are yet easily classed together physiologically. Besides, the Laticiferous tissues are not an essential part of the structure of a plant, as they are frequently absent. In examining the laticiferous tissues it is very useful to boil the specimens for a short time in dilute solution of caustic potash. This renders the rest of the tissue so transparent that the laticiferous vessels can be seen and traced with great distinctness. Plants belonging to the Cichoraceæ, Lobeliaceæ, and Campanulaceæ, are well adapted for the demonstration of the laticiferous vessels. In the plants belonging to these orders the laticiferous vessels are found in the fibro-vascular bundles, and form an anastomosing network permeating the whole plant. In the Cichoraceæ the laticiferous vessels are found in the outer layers of the Phloem part of the fibro-vascular bundles, while in the Campanulaceæ and Lobeliaceæ in the inner layers of the Phloem. In the Papayaceæ the laticiferous vessels are only to be found in the Xylem layer of the fibro-vascular bundles. In Papaver, Sanguinaria, Chelidonium, &c., the laticiferous vessels are also very perfectly developed in the Phloem, and singly in the pith and Xylem. They do not anastomose freely in the stem, but in the leaves, &c., they form a fine network. Laticiferous vessels seem to be formed by the fusion of rows of cells, the transverse partitions breaking down, and a continuous tube being in this way formed. In the Urticaceæ, Ficus, and Humulus, the laticiferous vessels are found in the limitary tissues close to the bast-bundles, and in Ficus also in the pith, but never in the wood. They generally occur as long single tubes, and are not regularly or distinctly branched like the vessels in the Papaveraceæ and Cichoraceæ. In the leaves, however, they seem to anastomose freely.

In the Euphorbiaceæ the laticiferous vessels resemble those of the Urticaceæ, but are easily distinguished by the thickness of the walls, which appear in section not unlike bast-fibres. They are developed most completely in the immediate vicinity of the bast-fibres, and run into the bark and pith, forming numerous anastomoses in the swellings below the leaves. The laticiferous vessels of the Asclepiadaceæ and Apocynaceæ still more closely resemble bast-fibres, having the same thickened and striated walls. They are sometimes found in the place of the true bast-fibres, and are often united in a bundle along with the bast-fibres in the Phloem. Other modifications are to be found in *Arum*, *Acer*, *Oleander*, &c.

Peculiar laticiferous tubes have been described by Hanstein as occurring in the onion. They contain a milky juice, and are long wide cells with cribriform walls. They exist in the bulbs and stems of several species of Allium, and are found to occur more freely in the bulb. Similar structures containing a fluid that is not milky occur in Narcissus, Leucojum, Galanthus, &c., the cells containing numerous Raphides. Other structures resembling laticiferous vessels are to be found in Scilla, Ornithogalum, &c., and tubes containing enormous Raphides are to be met with in plants belonging to the Order Commelynaceæ. Rounded cavities containing elongated cells filled with a milky juice have been described by Hildebrand as occurring in the leaves of *Psoralia hirta*.

Glands consist sometimes of single cells, at other times of groups of cells, and are generally easily distinguished from the cells in their immediate vicinity by their contents, such as oil, resin, colouring matters, &c. Many hairs are to be considered as glands, secreting peculiar matters, as stinging hairs. The epidermal cells may also secrete, as in the case of *Lychnis viscaria*, and the sweet materials secreted by many petals. Single glandular cells are to be met with in the primitive tissue of the leaf of the Camphor plant, while in many other plants groups of these cells are to be found. The formation of the material contained in these glandular cells seems to be a destructive process, the protoplasm disappearing and the cell-wall becoming variously modified. This is to be seen in the glandular hairs of Cannabis, Humulus, and Dictamnus.

Resin canals are to be met with in all the different tissues—Limitary, Primitive, or Fibro-vascular bundles. They are intercellular spaces, filled with peculiar oily or resinous materials. In general they follow the course of the fibro-vascular bundles, and do not anastomose. They are to be met with in Coniferæ, Cycadaceæ, Terebinthaceæ, Umbelliferæ, Araliaceæ, and Compositæ. The canals of the Coniferæ and Ivy seem to be the best known.

PROGRESS OF MICROSCOPICAL SCIENCE.

The Nature and Origin of Blood-globules.—MM. A. Béchamp and A. Estor have recently brought before the French Academy a paper on this subject, which will be found in 'Comptes Rendus,' 7th Feb., 1870. They remark that the blood-globules of man and the mammalia are usually regarded as small elastic masses, in which there is neither nucleus nor membrane. Deceived, they say, by their appearance under the microscope, these globules are taken for simple homogeneous masses, and they offer what they consider a demonstration that they are really masses of molecular granulations, agglutinated micro-ferments (*microzymas*). They state that when blood is received directly from the vessel which supplies it, in a glass containing alcohol (45°), it remains quite limpid, neither depositing fibrine nor globules. Soon, however, the transparency of the fluid is diminished, and an abundant deposit is found at the bottom of the vessel, which the microscope shows to be composed almost exclusively of molecular granulations free and mobile, or agglutinated. We can, they say, cultivate these granulations and promote their rapid proliferation. To do this the first mixture is thrown on a filter, the precipitate is retained, but some micro-ferments always pass, which are so prolific that at a temperature of 25° to 35° (C.) after a couple of hours another deposit takes place, and after thirty-six hours it is as abundant as the first. The same series of phenomena are repeated till the liquid has completely lost its colour, and materials of nutrition are no longer supplied. The experiment may be made with blood that has been beaten up and defibrinized: so it is not the fibrine which furnishes the micro-ferments; they come from the globules, in which they may be found by simple methods.

The globules may be retained on the filter after a preliminary action upon them of solution of sulphate of soda. They are then placed on a glass slab and ground with a glass muller. By these means the globules are torn, and the micro-ferments, set free, swim in the liquid, with their proper oscillatory motion.

This experiment may be varied by taking a drop of defibrinized blood, and placing it under the microscope, when a mass of globules will be seen, in which it is often difficult or impossible to find a single micro-ferment. Let a drop of distilled water be placed so as to pass under the glass cover of the object, and as it penetrates, the globules grow pale, and then become granular, soon breaking up and leaving in their place masses of very mobile micro-ferments, without a trace of pre-existing membrane.

The micro-ferments of blood behave like those of the liver in this method of evolution, and like those of fibrine. For at first they can, under certain circumstances, attach themselves together in chaplets more or less long. Placed in vials containing diluted starch creosoted, with or without addition of pure carbonate of lime, they rapidly develop into bacteria and bacterides.

These micro-ferments of blood-globules behave like ferments first under the form of microzymas, then in chaplets, and bacteria during, or after, this evolution. The starch of flour is rapidly liquefied by them; the mixture soon presents the characters of soluble starch and dextrine. If pure carbonate of lime is added previously to the starch liquid, and it is filtered, after a prolonged reaction the mixture lets fall a precipitate occasioned by the oxalic acid formed under the action of the ferments, which sometimes remain in the mycrozymic condition all the while, showing that this evolution into chaplets and bacteria is not necessary to their action upon the starch. The starch mixture is always rendered fluid before the appearance of the bacteria.

The writers affirm that the micro-ferments still contained in the cells are in a condition for reproduction. They say they have often seen the birth of a great number of small cells, pale, slightly segmented (*framboisées*), and much resembling leucocytes, but usually smaller and more transparent. They have sometimes found twelve to fifteen, in the field of Nachet's No. 7, at one time, in liquid which some days before did not show a single one; and these cellules have never exhibited the characters of organs in proliferation, such as scission or budding. On the contrary, they have often seen very pale cells scarcely indicated by the micro-ferments agglomerated in spheres and motionless, and others more sharply defined, and further on true leucocytes.

From the preceding facts the writers conclude that the blood-globules are aggregates of micro-ferments (*mycrozymas*); that these mycrozymas can develop into chaplets of beads, into bacteria, or bacterides, &c.; that they behave like ferments; that the mycrozymas of blood-globules give birth to cells like leucocytes, and to other smaller cells, more resembling the globules. These mycrozymas are thus capable, in various media, of engendering cells, and so lead us to believe that the globule of blood, as an organism, is the result of the work of these mere micro-ferments.

Amongst other things which they conclude—somewhat hastily—is, that respiration belongs to the class of phenomena termed fermentation.

Leptothrix and Vibrio Bacillus.—MM. Giuseppe Balsamo Crivelli and Leopold Maggi have an important paper in the 'Rendiconti del Reale Istituto Lombardo,' ser. ii., vol. i., p. 11, on the above organisms. They affirm that the leptothrix, the vibrio mentioned above and several others, are developments from granules of the vitelline membrane of an egg, or from epithelial cells of the tongue, and that for their appearance no spores are required, nor germs floating in the air, but only the transformation of a morphological element.

The Growth of Organisms in contact with Phenic Acid.—The preceding authors detail several instances of vibrions and bacteria appearing in animal solutions containing phenic acid; but they state that the acid kills them when their organization is complete.

NOTES AND MEMORANDA.

The Mechanism of Suppuration.—Experiments of M. Hayen brought before the French Academy of Medicine by M. Vulpian, overturn the theories of Virchow and Robin, by showing that the globules of pus are not formed at the expense of the connective tissue or of the blastema, but they come from the blood, and constitute its leucocytes. M. Hayen's experiments were made with frogs, but M. Vulpian and after him MM. Volkmann and Stradener have shown that in erysipelas a considerable extravasation of the white globules occurs, which is easily proved by cutting the skin. A Dutch physiologist, M. Costa, has demonstrated this extravasation of white globules in inflamed spots.—*Cosmos.*

Microscopic Crystals in Minerals.—Mr. Isaac Lea has a paper on this subject in the 'Proceedings of the Academy of Natural Sciences, Philadelphia.' He found minute acicular crystals in a thin piece of fractured gravel from North Carolina. This led him to examine other stones, and he found in garnets a much larger proportion with crystals than M. Babinet had noticed, no less than 48 with acicular crystals in 154. In precious garnets from Green's Creek, Delaware Co., Penn., out of 310 specimens he found 75 with similar crystals. In a second paper Mr. Lea mentions his examination of a star sapphire with six rays, in which he discovered exceedingly minute crystals, short, of pearly lustre, at three different angles, these producing the bands which form the rays in three directions of 60° each. In a bluish sapphire in Prof. Leidy's collection, he discovered some arrow-headed crystals, which he thinks may be twin crystals of some unknown substance. He says they remind him of certain silicate crystals from the Paris basin, and resemble in form the cuneiform inscriptions on Babylon bricks. In an amethyst from Thunder Bay, Lake Superior, he noticed some remarkable globules, some orange-yellow, and others dark green; they are visible to the naked eye, but are not spherical, some being cup-shaped. A brilliant ruby, looking like an Oriental, but which may be Spanish, was full of long acicular crystals. Figures of many of these crystals are given in the paper.

Amœbæ and Monads.—In the 'Proceedings of the Bristol Naturalists' Society,' just issued (vol. iv. part 2), Dr. Fripp gives a paper on the above subject, in which he describes the views held by Greef and Cienkowski, and adds some interesting observations of his own. Dr. Fripp is, we believe, a pupil of Kölliker's, and is so well known for his laborious researches in certain departments of comparative anatomy, that this fact alone would render his paper attractive. But apart from this, we can assure our readers that they will find in Dr. Fripp's communication to the Bristol Society a very long and important account of recent continental researches on the Amœba and the Monad.

The Soirée of the Old Change Microscopical Society, which was held in the City Terminus Hotel, Cannon Street, on the 14th ult., was an immense success. The programme giving a list of the objects exhibited, reflects great credit on the Society, and shows how indefatigably the Secretary and other officers of the Society must have worked in organizing the conversazione.

A New Method of Adjusting the Focus of Microscopes.—At the meeting of the Birmingham Natural History Society on the 8th of February, Mr. Thos. Fiddian, whose excellent microscope lamp was described in one of our early numbers, read an interesting paper on the above subject. It would be impossible without the aid of the lithographs which accompanied Mr. Fiddian's paper to give an accurate idea of the method of focussing which he suggests. But as the paper has been printed for circulation, any of our readers can obtain it for themselves by writing to the author.

A New Vaginicola.—Mr. F. J. Warner, of Winchester, contributes to 'Science-Gossip' for February an account of a species of *Vaginicola*, which he considers to be new to science. Referring to the *V. valvata* described and figured by Mr. Slack,* and which he believes to be the only fresh-water valved vaginicola hitherto described, he says that it differs materially from the species he has recently observed, in which the lorica is urceolate or vase-shaped, hyaline, and terminating at the foot nearly in a point. The valve, which is very delicate, and in some instances requires careful illumination in order to distinguish it, is attached to the side of the lorica about one-third of its length from the top, and moves freely on its point of attachment, moving up on the protrusion of the animal, and immediately closing again on its withdrawing itself, which it does very rapidly on being alarmed, as for instance. by a tap on the glass stage or trough. The body when expanded is about $\frac{1}{80}$th of an inch long, and gradually tapers from the head, which is crowned, to the foot. When retracted it is pear-shaped, a slight tuft of cilia being generally apparent at the broader end. The body is nearly filled with green granules, and several well-marked vacuoles are to be seen. Mr. Warner gives the following as the technical description :—

Vaginicola —— (?); tube or lorica crystalline, urceolate about $\frac{1}{125}$th of an inch in length, with a valve apparently formed of the same substance, affixed to the side about one-third of its length from the top, and moving freely on its point of attachment, closing in an inclined position over the animal on its withdrawing itself into the lorica. Body about $\frac{1}{80}$th of an inch in length, with many vacuoles, and nearly filled with bright green granules.

Hab. fresh-water on *Chara*, &c.

Microscopic Teratology.—A paper on this subject was read at the last meeting of the Reading Microscopical Society. It is full of novel points of interest. We shall reproduce it in our next number.

* 'Intellectual Observer,' vol. ix., p. 205.

The Microscopic Structure of Rocks.—Mr. J. A. Phillips has sent us the reprint of a paper in the 'Philosophical Magazine' for December. In this the author, in describing certain slates, felsites, and elvanites in the county of Waterford, Ireland, gives an account of the structure as seen under the microscope, and the paper may therefore be of interest to our micro-geologists. He describes four specimens. The first is an elvanite of specific gravity 2·66; a section of this was observed. Examined under a ½-inch objective, this rock, says the author, is seen to be composed of an amorphous greyish matrix in which are porphyritically imbedded crystals of quartz and felspar, the latter being chiefly oligoclase. In addition to these, a few small crystals of some hornblendic mineral are sparingly disseminated throughout the mass. It was further observed that the larger quartz-crystals are sometimes penetrated by crystals both of felspar and hornblende; and when examined under a high power, the quartz is seen to contain fluid cavities. The next was a felsite of sp. gr. 2·64. Under the microscope this was found to consist of a colourless and generally amorphous matrix enclosing a few dodecahedral crystals of quartz and some small crystals of felspar. Other portions of the matrix appear to be indistinctly crystalline, and to enclose a few laminæ of a greenish mineral, probably chlorite. The next was a columnous slate of sp. gr. 2·66. A section of this slate, made parallel to one of its lines of cleavage, when examined under the microscope, was found to consist of an amorphous matrix through which is somewhat thickly disseminated a flocculence of a dirty greenish colour, perhaps due to the presence of minute quantities of chlorite. A few well-defined quartz-crystals were also apparent. The last was a metamorphosed slate of sp. gr. 2·65. A section prepared from a band, apparently of highly metamorphosed slate, lying to the east of the foregoing, in which the cleavage-planes had to a great extent become obliterated, was found under the microscope to be chiefly composed of felspathic-looking crystals crossing each other in all directions, with here and there some minute scales of chlorite. These crystals, which readily depolarize polarized light, are nearly transparent; but the small amount of potassa, soda, and lime present in the rock, as shown by analysis, renders it improbable that so large a proportion of it can consist of any variety of felspar.

CORRESPONDENCE.

Ponceane or Aniline Red, as a Substitute for Carmine in Microscopic Colouring.

To the Editor of the 'Monthly Microscopical Journal.'

Sir,—This substance, which is one of the Aniline series of dyes, produces, when mixed with warm water (about five grains to a pint), a most admirable colouring medium for microscopic investigations. From the experience I have had of its properties, it seems likely to be useful as a means of distinguishing between separate structures, uniting with some but leaving others coloured as before. Epithelial starch granular matter, as of brain and other animal matters, is coloured by it in various shades. The Soredial tubes of Chlorococcus are coloured, while the Gonidia remain green. It seems to possess the valuable property of not arresting the vitality of organisms, such as Vibrio or Monas.

Metcalfe Johnson.

PROCEEDINGS OF SOCIETIES.*

Royal Microscopical Society.

King's College, *February* 9, 1870.

Rev. J. B. Reade, M.A., F.R.S., in the chair.

The minutes of the last meeting were read and confirmed.

A list of donations to the Society was also read, and a vote of thanks passed to the respective donors.

The President then delivered his Address, in which he announced his intention of presenting to the Society his copy of the 'Philosophical Transactions:' sixty volumes, *in extenso*, from 1665 to 1812, and twelve volumes of 'Transactions abridged,' from 1665 to 1750, are whole or half-bound. The parts from 1813 to the present time are in boards, as issued by the Royal Society. The President stated that a few parts, borrowed or otherwise missing, will be replaced.

After reading the obituary list for the past year, the President paused in his Address, for the purpose of communicating to the So-

* Secretaries of Societies will greatly oblige us by writing their reports legibly —especially by printing the technical terms thus: H y d r a—and by "underlining" words, such as specific names, which must be printed in italics. They will thus ensure accuracy and enhance the value of their proceedings.—Ed. M. M. J.

ciety Professor Lister's account of his late father's microscopical labours. This important historical document was received with most cordial thanks to Professor Lister from all the Fellows present.

It was moved by Mr. C. Brooke, and seconded by Mr. J. H. Wenham, "That the cordial thanks of this meeting be presented to the President for the most able and lucid Address which he has just delivered."

The vote of thanks was unanimously carried, and briefly acknowledged by the President.

It was moved by Mr. Slack, and seconded by Mr. E. G. Lobb, and unanimously agreed to, "That the thanks of this meeting be given to Mrs. Holland for the valuable present she had made to the Society, and to which the President had referred in his Address."

Mr. E. G. Lobb moved, and Mr. Peter Gray seconded, the following resolution :—"That the best thanks of this meeting be given to the President for his magnificent present of the 'Philosophical Transactions' to the Society." The resolution was unanimously carried.

The President acknowledged the vote.

It was then moved and seconded, and agreed to, that Messrs. J. Browning and J. Hilton be requested to act as Scrutineers in the election of officers for the ensuing year.

Mr. Slack, in reply to a question from Mr. Tupholme concerning Dr. Greville's drawings of diatoms, stated that Dr. Lankester had written to say that Dr. Greville had latterly superintended the execution of the plates in Edinburgh, and that the drawings had been returned to him for that purpose. It was further stated that Dr. Lankester had been requested to send to the Society every drawing in his possession, and which, according to the bye-laws, belonged to the Society, but that he had failed to comply with the request.

The Library Committee reported that the books generally were in good condition, that the numerous valuable donations had been periodically announced in 'The Monthly Microscopical Journal,' and that the purchases were as follows, *viz.*:—Owen's 'Anatomy,' Vol. III.; Bate and Westwood's 'Sessile-eyed Crustacea,' 2 vols.; Hinck's 'Zoophytes,' 2 vols.; Jeffrey's 'Conchology,' Vol. V.; Cobbold's 'Supplement to the Entozoa;' Lowne's 'Anatomy of the Blow-fly.' They hoped in future years a larger sum would be appropriated to the acquisition of important works, and that they should be enabled to extend the system of exchange with foreign societies.

The Scrutineers announced that the whole of the officers proposed for the ensuing year had been unanimously elected.

Mr. Slack then brought before the meeting the question of refreshments after the ordinary meetings of the Society. The subject had been alluded to at the previous meeting, and he had little to add to his remarks on that occasion. After a few remarks by Messrs. Browning, Gray, and Beck, it was moved by Mr. Tyler and seconded by Mr. Stevenson, "That the custom of providing refreshment after the meetings of the Society be for the present discontinued." This motion was supported by Messrs. Lee and Hogg, and carried unanimously.

Mr. Slack announced that at the next meeting of the Society Dr.

Carpenter had promised to attend and bring before the notice of the Fellows some Microscopic Memoranda:—

1. "On the comparative steadiness of the Ross and Lister Models under trying circumstances."
2. "On the Shell Structure of the Fusulina."
3. "On the Micropyle of the Fish's Ovum."
4. "On the Reparation of the Spines of Echini."

The meeting was then adjourned to the 9th of March.

Mr. Brooke exhibited, at the close of the meeting, a very convenient and modified form of a travelling or portable microscope, which excited much interest.

RICHARD MESTAYER, TREASURER, IN ACCOUNT WITH THE ROYAL MICROSCOPICAL SOCIETY.

	£	s.	d.		£	s.	d.
To Balance brought forward ..	266	0	9	By Payments to Mr. Hardwicke for Journal	234	3	0
„ Subscriptions for 1866 ..	1	1	0	„ Printing	24	12	9
„ „ 1867 ..	1	1	0	„ Binding, &c.	3	5	0
„ „ 1868 ..	7	7	0	„ Rent and other expenses, King's College	59	14	4
„ „ 1869 ..	298	3	0	„ Refreshments	25	4	3
„ „ 1870 ..	4	4	0	„ Instruments	35	0	0
„ Dividend on 1059*l.* 6*s.* 2*d.* Consols	15	11	2	„ Assistant Secretary ..	57	15	0
„ Tap and Screws sold ..	0	7	0	„ Soirée	65	13	7
„ Donation to the Tea Fund	0	19	0	„ Petty Cash	23	11	6
				„ Reporter	6	6	0
				„ Collector's Commission ..	7	5	3
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	£594	13	11		£594	13	11

Examined and found correct,

JOHN BOCKETT, W. T. SUFFOLK, } *Auditors.*

25th January, 1870.

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Donations to the Library from January 12th to February 9th, 1870:—

	From
Land and Water. Weekly	*Editor.*
Society of Arts Journal. Weekly	*Society.*
Nature. Weekly	*Editor.*
The Student	*Publisher.*
Journal of the Linnean Society	*Society.*
Scientific Opinion. Part XV.	*Editor.*
Microscopic Objects, figured and described by J. H. Martin. No. 1	*Publisher.*
The Chemical News. 5 Nos.	*W. T. Suffolk, Esq.*
Notes on Microscopic Crystals included in some Minerals. By Isaac Lee	*Author.*
Synopsis of the British Sea-weeds. By W. H. Harvey ..	*W. W. Reeves.*
The Philosophical Transactions from 1665 to the present time, being complete as published from 1751 to 1870	*The President.*
A Micrometer ruled on silver, by Mr. Barton	*Mrs. Holland.*
Three Specimens of the Beads and Bead-lenses made by the late Mr. Holland	*Mrs. Holland.*
The Silver Medal of the Society of Arts awarded to her late husband for his Micrposcoic Triplet	*Mrs. Holland.*

George Lewis, Esq., was elected a Fellow of the Society.

Walter W. Reeves,
Assist. Secretary.

Quekett Microscopical Club.†

At the ordinary meeting of the Club, held at the University College, January 28th, 1870, P. Le Neve Foster, Esq., M.A., President, in the chair,—six gentlemen were balloted for and elected members of the club, four gentlemen were proposed for membership, and a number of presents to the library were announced. A paper was read by Dr. R. Braithwaite, F.L.S., "On the Geographical Distribution of Mosses in Europe," which was for the purpose divided into three zones in latitude, *viz.* the Arctic, from the Pole to 60° N.; the Middle, from 60° N. to 46° N.; and the Southern, extending from 46° N. to the shores of the Mediterranean Sea. In altitude, five zones were also described, with the classes of mosses to be found in each. The general aspects of mosses in nature, with their habitats, as well as the ferns frequently associated with them, were also touched upon by Dr. Braithwaite, who concluded his very interesting paper with a quotation of much beauty from the pen of Mr. Ruskin. The paper was illustrated by a large collection of dried specimens, mounted together according to their

* Those with the asterisk before their names were not before members of Council.

† Report supplied by Mr. R. T. Lewis.

localities. A cordial vote of thanks to Dr. Braithwaite was then passed for his paper, and after an announcement of the subjects of papers for the meetings in February and March, the proceedings terminated with a conversazione, at which some interesting objects were exhibited under microscopes, and much attention was attracted by the collection of Mosses and Ferns illustrative of the paper of the evening.

Literary and Philosophical Society of Manchester.

Ordinary meeting, February 8th, 1870. J. P. Joule, LL.D., F.R.S., &c., President, in the chair.—The following interesting botanical paper was the only Microscopical communication:—

"On the Natural Ropes used in packing Cotton Bales in the Brazils," by Charles Bailey, Esq.

Most of the cotton bales which reach this country from the Brazils are corded with long stems of climbing plants, which grow in the greatest profusion in the forests bordering on the cotton districts. In their fresh state these stems are exceedingly pliant and of remarkable strength, so that they serve admirably for cordage purposes, but by the time that the cotton reaches the mills of Lancashire they become dry and rigid, and as no further use can be made of them, they are burned for firewood. Being very long, they are very troublesome to put on the boiler fires, and most millowners are glad to get rid of them.

These objects are invested with singular interest when examined in regard to their structure, for although the external form of many of them is extremely curious, their chief interest centres in their remarkable internal organization. Although they reach this country in immense quantities, they are not often to be met with in our museums or colleges; it may be questioned whether any one of our public institutions possesses a complete collection of these stems; certainly the names of the plants which produce them are for the most part unknown.

My attention was first directed to them by Mr. Robert Holland, of Mobberley, in a paper which he read on the 7th December last, to the "Manchester Scientific Students' Association," on "Some peculiar forms of Exogenous Stems," and to this gentleman, to Mr. Randall Alcock, of Bury, to Mr. Alderman Thompson, of Blackburn, to Mr. Richard Thompson, of Padiham, to Mr. Spencer, of Manchester, and to Mr. Griffiths, of Liverpool, I am indebted for an abundant supply of these ropes.

It is not so much my object on this occasion to give a detailed account of the many forms met with, as to give some general description of them, classifying them for the most part under the natural orders to which they probably belong; but I may preface these notes with a short summary of the little which has already been written concerning them.

One of the earliest to minutely study this class of plants was Charles Gaudichaud, a botanist who visited Chili, Peru, and the Brazils in 1830, and who subsequently published a memoir, entitled, 'Recherches générales sur l'organographie, la physiologie, et l'organogénie des Végétaux,'* in which will be found a large number of engravings of many lianas, but very little descriptive matter; the memoir was written to support the views of Du Petit-Thouars in regard to the growth of wood, and in opposition to the views of other leading botanists, but little is said about the climbing plants. The most complete general account of their structure which I have met with is that by Adrien de Jussieu—'Sur les tiges de diverses Lianes, et particulièrement sur celles de la famille des Malpighiacées;'† this was afterwards reprinted, with additions, and incorporated in the same author's 'Monographie de la famille des Malpighiacées.'‡ Another account of their organization is included in the eighth volume of the 'Botanische Zeitung,' by Hermann Crüger, entitled 'Einige Beiträge zur Kenntniss von sogenanntnen anomalen Holzbildungen des Dikotylenstammes,' and published in 1850. Notices of the structure of other lianas are also to be met with in isolated memoirs, some of which will be referred to, and in most botanical text-books, particularly in those of Lindley, Schleiden, Richard, and Duchartre. Much important information may also be anticipated from some recent memoirs by a Brazilian botanist—Dr. Ladislaü Netto, who has presented memoirs on the subject to the French Academy, extracts from which have only so far been published in the 'Comptes Rendus' and 'Annales des Sciences' for 1866, 1867, &c. §

Microscopical and Natural History Section of the Manchester Literary and Philosophical Society.

January 3rd, 1870. R. D. Darbishire, B.A., F.G.S., in the chair.

Dr. Wm. Roberts exhibited some specimens of urinary calculi, composed of cystine; also some crystals of the same, obtained by evaporation in the open air of the ammoniacal solution. Six-sided plates of mother-of-pearl lustre were obtained in this way, which formed brilliant objects for the microscope.

Mr. J. Sidebotham read a paper, entitled "Notes on the Pupa and Imago of *Acherontia atropos*."

Mr. W. Boyd Dawkins, F.R.S., sent for exhibition some very interesting microscopic sections of *Eozöon Canadense*, which are the more valuable as being those which have passed through the hands of Sir W. E. Logan and Dr. Carpenter.

Mr. J. B. Dancer, F.R.A.S., presented the Section with a box containing twelve new polarizing objects. These partly consisted of some of the hard fatty acids which form very effective objects, and partly of crystallizations of some of the hydro-carbon compounds which compete with the best specimens of polarizing objects of the present day.

* 'Mém. Savans Etrangers, t. viii., Paris, 1835.

† 'Annales Sciences Naturelles,' t. xv., Paris, 1841.

‡ 'Arch. du Mus.,' t. iii., Paris, 1843.

§ Owing to pressure of matter the remainder of this interesting paper has been "crushed out." It shall appear in our next Number.—Ed. M. M. J.

Reading Microscopical Society.*

February 15th, 1870.—Captain Lang presided, and after the ordinary business Mr. Amner read a paper upon "The Use of the Microscope in the Detection of Adulterations," confining himself mainly to the adulterations of tea, coffee, cocoa, and sugar, and describing the microscopical characters of the genuine substances, as well as of those added. The subject was illustrated by drawings and mounted specimens.

The President read a paper by Mr. Tatem, entitled "A Contribution to the Teratology of the Infusoria," in which were described the results of hypertrophy, or of arrested development in examples of *Trachelius anas*, *Chilodon cucullus*, *Vorticella convallaria*, *Melicerta*, and *Stephanoceros Eichornii*, &c. To these the writer attached some importance, as helping to indicate the fixity of specific characters. Drawings of the aberrant forms accompanied the paper.

Mr. Tatem also exhibited slides of diatoms mounted symmetrically.

Brighton and Sussex Natural History Society.†

February 10th.—The President, Mr. T. H. Hennah, in the chair.

The receipt of 'Catalogue of Works on the Microscope,' by Mr. R. C. Roper, from the author, and 'Microscopic Objects Figured and Described,' by J. H. Martin, from the publisher, was acknowledged.

The Hon. Sec., Mr. T. W. Wonfor, exhibited and read a description of a series of gall-nuts found on English plants, collected by Mr. W. H. Kidd, and presented by that gentleman to the Brighton Museum.

Mr. T. W. Wonfor then read a paper "On Seeds."

After tracing the seed from its first appearance as a mere pimple, in the unexpanded flower-bud, through the ovule, and its impregnation to the perfect seed, with a description of the several parts and their economy, the mode of dissemination, the power of resisting heat and cold, the wonderful property possessed by some seeds of preserving their vitality under apparently adverse circumstances for long periods of years, and the advantages accruing from artificial selection, were each discussed; on the last point attention was called to what had been done by Mr. F. Hallett, of Brighton, with wheat. Seeds as microscopic objects were next discussed. Having spent several years in the collection and examination of wild and cultivated seeds as microscopic objects, Mr. Wonfor thought that few things in the vegetable kingdom presented such diversity of form, markings, and beauty. Although unwilling to lay down any law for classification by means of the appearances of seeds, yet often in the case of unknown seeds he had been able to name the family to which they belonged, from certain peculiarities common to many plants of the same family. Among some of the most interesting families might be mentioned the Scrophulariaceæ, containing the Mulleins, Foxgloves, Antirrhinums, Figworts, Paulownias, &c.; the Papaveraceæ, many of which were very

* Report supplied by Mr. B. J. Austin.
† Report supplied by Mr. T. W. Wonfor.

beautiful objects; the Caryophyllaceæ, or pink family, containing a very great variety of very beautiful seeds, not the least beautiful being the common chickweed and ragged-robin; and the Orchidaceæ, characterized by what had been termed the appearance of net-purses containing a single gold coin. The majority required no other preparation but that of being mounted dry; some, like the orchids, when mounted in balsam, were good polariscope objects. For making out the several coats of the seed and the embryo, sections cut on the plan recommended by Dr. Halifax gave admirable results. The paper was illustrated by a large collection of seeds under the microscope and otherwise, and by microscopic preparations, including sections showing the several parts made by Dr. Halifax.

Bristol Microscopical Society.

Wednesday, February 16th.—Mr. W. J. Fedden, President, in the chair.

The minutes of the preceding meeting were read and confirmed, and some other business transacted.

Mr. Roper was balloted for as, and elected, an honorary member of the Society.

Mr. T. G. Ponton, F.Z.S., Hon. Sec., then read a paper "On some Points in the Anatomy of *Tegenaria domestica*—the House Spider," especially in reference to the nervous and circulatory systems.

Tunbridge Wells Microscopical Society.*

The second meeting of this Society was held on the 1st instant at the house of the President, Dr. Deakin, who read a paper "On the Anatomy of Lichens," which was most clearly and ably demonstrated. He exhibited some very beautifully executed drawings of the peculiar construction of this interesting class of plants, showing the internal structure of the thallus and the reproductive organs, as well as a large number of very beautiful specimens of the plants themselves.

Two new members were elected.

The subject for the next meeting will be Diatoms.

Oldham Microscopical Society.

On Tuesday evening, the 11th January, the members of the Oldham Microscopical Society held their annual meeting, which was very well attended. The summary of the year's proceedings, read by the President, showed that the Society was in a prosperous state, having doubled the number of its members and realized a respectable balance. The following subjects had passed under consideration, and papers been read upon them by members, *viz.* "The best mode of Measuring the Angle of Aperture of Object-glasses," "The Spider microscopically considered," "Our British Mosses," and "The Microscope in Geology."

After the business was concluded, a pleasant evening was spent in viewing the numerous beautiful objects brought by the various members and exhibited under their instruments.

* Report supplied by the Rev. B. Whitelock.

Old Change Microscopical Society.

President, Charles J. Leaf, Esq., F.L.S., &c.—The fourth annual soirée of this Society was held at the City Terminus Hotel, Cannon Street, on Monday, February 14th.

The weather being so very severe, the living objects exhibited were not so numerous as on other occasions; but amongst them were included *Lophopus crystallinus* (the President), *Fredicella sultana* (Mr. Madle), Ciliary action in Mussel (Mr. Wray), *Stephanoceros Eichornii* (Mr. F. H. Leaf), *Polyzoa* (Mr. T. Ross), and many other illustrations of pond life.

Amongst the mounted objects the most conspicuous were a series of slides by Dr. Carpenter, V.P.R.S., illustrative of his recent dredging expedition in the North Sea in H.M.S. 'Porcupine,' and which were well shown in Mr. Crouch's microscopes. Mr. W. Carruthers exhibited "Silicified starch granules from *Eocene* strata;" and Dr. Dempsey, circular crystals of *Saliginene.*

Mr. W. C. Roberts, F.C.S., the chemist to the Mint, illustrated the value of the microscope as a *detective*, by showing a sovereign which had been tampered with to the extent of two-pence, and which clearly evinced the "sweating" process it had undergone.

Mr. T. Curteis, F.R.M.S., exhibited some very beautiful drawings of microscopic objects, executed by Messrs. Richter and E. T. Draper, which were much admired.

Mr. W. Ladd illuminated his microscopes and those in the immediate vicinity by the new Oxy-hydrogen Zirconia light, which seems to be as intense as the electric, and with more steadiness. Mr. C. Tyler, F.L.S., was surrounded by numerous admirers of some very fine type slides—sections of *Dactylocalyx pumiceus*, *D. Prattii*, *D. subglobosa*, *Iphiteon panicea*, &c.

The objects in general in the 250 microscopes, although well known to experienced microscopists, were many of them *new* to the visitors, who scanned them and questioned the exhibitors upon them with more than usual interest—the various anatomical slides especially attracting their attention.

The display, in the "Art Room," of water-colour drawings, stereoscopes, graphoscopes, works of art, photographs, and scientific works, &c., proved very attractive. In the same room Dr. Hawksley's stethosphygmograph, for recording the movements of the lungs, heart, and pulse simultaneously, was repeatedly tested and explained by the inventor and Dr. Armstrong. The "Natural History Room" was literally crammed with specimens of the three kingdoms—Animal, Vegetable, and Mineral—conspicuous amongst them being some very beautiful cases of birds, &c., by Mr. W. E. Dawe, jun.; some fine drawings and photographs of plants, by Mr. Fitch and Mr. D. R. Jackson, of Kew; and some thirty or forty cases of *Lepidoptera* and *Coleoptera*, exhibited by Miss Loddiges.

The Committee of the Guildhall Library, with their usual liberality, filled the "Antique Room" with a large variety of rare books, &c., including the 'Ceremonial of the Coronation of George IV.,' and a piece of Roman pavement recently found in excavating in Bucklersbury.

Mr. J. How and Mr. Thomas E. Hooker entertained the company in the "Dark Room:" the former, by an exhibition of photographs, &c., from various parts of the world, photo-micrographs, kaleidoscope effects, &c.; and the latter, with a series of electrical experiments and vacuum tubes, &c.

The refreshments were on the most liberal scale, and the whole entertainment passed off with more than the usual satisfaction. The company included—The President of the Royal Microscopical Society (the Rev. J. B. Reade, F.R.S.), Mr. James Glaisher (the ex-President), the Lord Mayor and Lady Mayoress, &c.

Friday, February 18th, 1870.—The President in the chair: about sixty members and visitors present. Dr. Lionel Beale, F.R.S., delivered a lecture "On Demonstrating the Living Matter of Living Beings," which he illustrated by means of numerous diagrams and slides exhibited in his clinical microscope.

The thanks of the Society were unanimously awarded to Dr. Beale.

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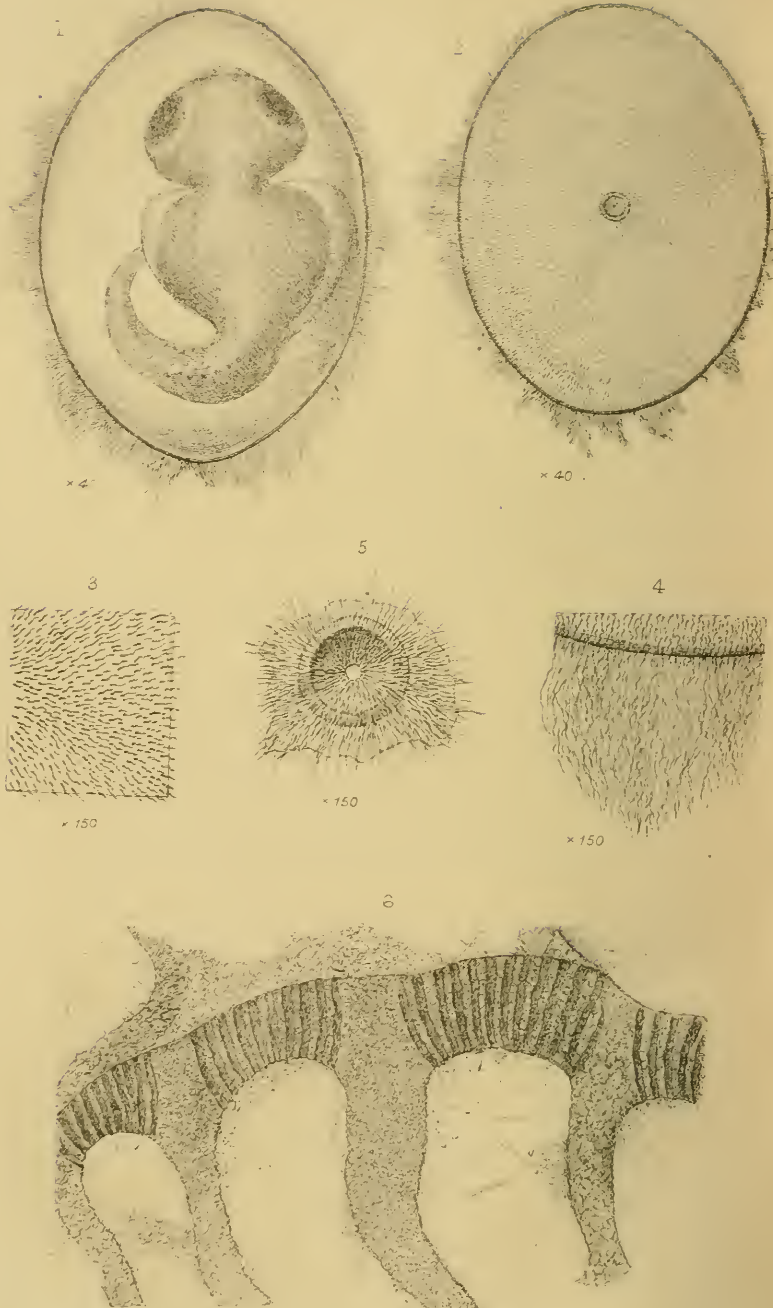
Essai sur l'Œplœsie lamineuse progressive (atrophie du tissu connectif), celle de la Face en particulier (trophonévrose de Romberg). Par le Docteur Louis Lande. Paris. V. Masson et Fils.

Les Métamorphoses des Insectes. Par Maurice Girard. 3e Edition. Paris. Hachette et Cie.

Cryptogames vasculaires (Fougères, Lycopodiacées, Hydropterydées, Equisetacées) du Brésil. Par A. L. A. Fée, Professeur de Botanique à la Faculté de Médecine de Strasbourg, avec le Concours de M. le Docteur F. M. Graziou, Directeur des Jardins impériaux du Brésil à Rio Janeiro. Matériaux pour une flore générale de ce pays. Strasbourg et Paris. Berger-Levrault et Fils.



Tuffen West ad nat. sc.

W. West imp.

Peculiar fish-ovum
Structure of Fusulina-shell

THE

MONTHLY MICROSCOPICAL JOURNAL.

APRIL 1, 1870.

I.—*Description of some peculiar Fish's Ova.*

By W. B. Carpenter, M.D., F.R.S.

(*Read before the* Royal Microscopical Society, *March* 9, 1870.)

Plate XLV.

More than thirteen years ago, when dredging in Lamlash Bay, Arran, in the month of August or September, I brought up from a depth of thirty or forty fathoms a fragment of a Bivalve Shell, on the internal surface of which I noticed some minute bodies, whose appearance under a hand-magnifier was so unusual as considerably to perplex me. On submitting them to a higher magnifying power, it at once became obvious that they were the Ova of a Fish; for some of them contained embryoes in a state of advanced development, whilst from others the mature embryoes were in the very act of escaping, others, again, being entirely empty. Further examination disclosed some very curious features in these Ova, which I should have described long since (as Prof. Kölliker, to whom I showed them at the time, urged me to do), if I had been able to find any clue to their parentage. But having neither again met with them, nor been able to obtain any information from the Lamlash fishermen that could help me to determine this point, I deem it better to put on record the results of my observations, in the hope that some other Naturalist may be able to complete them by the discovery of the Fish by which these ova are produced, and by the study of the earlier stages of the development both of the ovum itself and of the embryo which its fecundation generates.

The peculiarities which I have to describe have reference (1) to the Shape of the Ova; (2) to the mode of their Attachment to the surface of the Shell; (3) to the position and remarkable distinctness of the Micropyle.

1. So far as I am aware, the Ova of Fish (save those of the Plagiostome family) have been hitherto described as either spherical or ellipsoidal. These ova, on the other hand, are nearly *hemi-ellipsoidal;* having one surface plane and the other convex (Plate XLV., Figs. 1, 2). The plane surface is an ellipse, the longitudinal diameter

of which averages about 1-20th inch, and the transverse about 1-25th inch; the proportion of the former to the latter being thus as 5 to 4. But this proportion is liable to variation; some ova being more elongated (Fig. 1), and others more nearly hemispherical, than ordinary.

2. The Ova of Fishes, if attached at all, are usually made to adhere, either to each other or to solid surfaces on which they are deposited, by an albuminous secretion formed around them during their passage outwards from the ovary, just as in the well-known case of the spawn of the Frog. In some instances, however, the connection of the ova with each other is formed by villous appendages, which may either spring from the whole surface of the shell-membrane, as in the *Perch*, or may be limited to one portion of it, as in the *Stickleback*. Such villous filaments are here found proceeding from the under or flat side of the shell-membrane; and whilst those arising from the central portion of the area are very short, those developed from its peripheral portion are of considerable length, forming a fringe which extends itself far from the margin of the ovum (Fig. 2); and these tie down the ovum to the subjacent surface by their firm adhesion to it. The Shell-membrane itself appears to me a simple horny pellicle of great transparence, possessing no structure whatever. I have searched in vain for the fine tubulation detected by Prof. Müller in the shell-membrane of the egg of the Perch,* and by Prof. Allen Thomson in that of the Salmon and Trout.† And the villous filaments proceeding from it seem mere extensions of the same structureless substance, springing from little papillary elevations of its surface. In Fig. 3 is shown, under a power of 150 diameters, a portion of this villous shell-membrane from near the centre of the flat surface; and in Fig. 4 a marginal portion with its fringe of elongated fibres. I feel confident that these filaments are not tubular, and that they have no epithelial investment; they cannot, therefore, be in any way likened to the villi of the Mammalian chorion; and it is obvious that their function is simply mechanical.

3. The Micropyle, or aperture in the investment of the ovum through which the *spermatozoa* penetrate to its interior, was first discovered in the ovum of the Stickleback (*Gasterosteus*) by Dr. Ransome in 1854,‡ but independently and almost contemporaneously in the ova of two species of *Salmo* by Professor Bruch, of Basle.§ Since that date it has been recognized in the many other ova, both Vertebrate and Invertebrate. I doubt, however, if it has ever been so distinctly seen as it can be in the ovum now

* 'Müller's Archiv.' for 1854, p. 186.

† Art. "Ovum," in 'Cyclopædia of Anat. and Phys.,' vol. v., p. 100.

‡ See Dr. Ransome, "On the Impregnation of the Ovum of the Stickleback," in 'Proceedings of Royal Society,' vol. vii. (1854), pp. 168–172.

§ 'Zeitschrift für Wissensch. Zool.,' Bd. vii., pp. 172–175.

under description (Fig. 5), in which its position is most peculiar,—the centre of the flat or attached side (Fig. 2). Here we find a perforation in the ordinary shell-membrane, having a diameter of 1-1800th inch, and surrounded by an area of about 1-300th inch in diameter, which has somewhat of the funnel-like character described by Dr. Ransome in the ovum of the Stickleback, and by Professor Allen Thomson in that of the *Salmonidæ*. I have not been fortunate enough to obtain such a side view of this depression as is represented by the latter author;* but from the slightness of the focal difference between its marginal and its central portion, I should infer that the depression of the latter is much less in this ovum than in that figured by Professor A. Thomson. Not improbably, however, the form of this part may have undergone some change during the process of embryonic development.

Looking to the position of the Micropyle, and the closeness of adhesion between the flat side of the Ovum and the subjacent surface, I think it can scarcely be doubted that the fertilization of the ovum by the entrance of the spermatozoa must have taken place previously to its attachment to that surface.

* *Op. cit.*, fig. 68, B.

EXPLANATION OF PLATE XLV.

FIG. 1.—Upper or convex aspect of hemi-ellipsoidal Fish's Ovum, with contained embryo. Magnified 40 diameters.

„ 2.—Lower or flattened aspect of similar Ovum, from which the embryo had escaped; showing the Micropyle in its centre, and its entire surface covered with filaments, which are longest at its margin. Magnified 40 diameters.

„ 3.—Portion of this surface near the Micropyle; and Fig. 4, marginal portion of the same surface, showing the relative length of the filamentous processes in the two situations. Magnified 150 diameters.

„ 5.—Micropyle, lying at the bottom of a shallow funnel-shaped depression. Magnified 150 diameters.

„ 6.—Section of a portion of the shell of *Fusulina*, showing the large perforations in its chamber-wall. Magnified 100 diameters.

II.—*On the Shell-structure of Fusulina.*

By W. B. Carpenter, M.D., F.R.S.

(*Read before the* Royal Microscopical Society, *March* 9, 1870.)

Plate XLV.

The Genus *Fusulina* was instituted in 1829 by Fischer de Waldheim for the reception of a group of fusiform Foraminifera, often attaining a considerable size, which occur in such abundance in certain beds of the White Carboniferous Limestone of Russia as to constitute the principal part of their material; entire specimens, as in the comparatively modern *Nummulitic* or *Alveolina* Limestone, being imbedded in a matrix which is in great part composed of fragments of the same organisms intermingled with other Microzoa. In consequence of its very close resemblance to *Alveolina*, both in external form and in general plan of structure, it has been ranked by many systematists in close proximity to that genus; and this position was assigned to it even by my excellent fellow-labourers Messrs. Parker and Rupert Jones,* notwithstanding that they remarked the essential difference between the single nummuline aperture which D'Orbigny had long before shown to be characteristic of *Fusulina*, and the multiplied pores which are distributed over the whole septal plane of *Alveolina*. My own investigations led me to the conclusion that the relation of *Fusulina* to *Alveolina* is one of isomorphism only, corresponding to that which frequently presents itself between types respectively belonging to the *porcellanous* or Imperforate and to the *vitreous* or Perforated series. For not only did they confirm the view of D'Orbigny as to the essential conformity of *Fusulina*, as regards its general structure, to the Nummuline type, but also afforded what I regarded as distinct evidence of perforation of the chamber-walls by closely-set parallel tubuli, intermediate in diameter between the fine tubuli characteristic of Nummuline shells and the coarse pores usually seen in the Rotaline. That the indications of the tubuli are not more distinct, and that no determination can be made of their precise diameters, arises from the metamorphic condition in which these shells are usually found; their ultimate texture having been greatly altered by molecular change, as is the case with most of the fossils imbedded in the Carboniferous Limestone.†

It was with great satisfaction that I subsequently found that Professor Reuss, having been led to adopt the ultimate texture of the shell as the basis of his classification of Foraminifera, had unhesitatingly ranked *Fusulina* in his series of vitreous finely-tubular shells, placing it after *Nonionina* in his family *Polystomellidea*, so as to lead to his family *Nummulitidea*.‡

* 'On the Nomenclature of the Foraminifera,' Part VI., 'Anna. of Nat. Hist.,' 3rd ser., vol. viii. (1861), p. 161.

† See my 'Introduction to the Study of the Foraminifera,' pp. 304–7.

‡ 'Entwurf einer Systematischen Zusammen stellung der Foraminiferen,' in 'Sitzungsberichte der mathematisch-naturwissenschaftlichen. Classe des kais. Akad. der Wissenchaften,' Bd. xliv. Wien, 1861.

About two years ago I received from Mr. Meek, of Washington, U.S., through Mr. Davidson, some very well-preserved specimens of *Fusulina*, from the Carboniferous Limestone of Iowa; an examination of which has fully confirmed my previous belief as to the perforate structure of its shell, whilst it has also enabled me to make such a precise measurement of the size of the pores, and of their distance from one another, as will settle, in my opinion, its precise place in the Vitreous series.

The exceptional condition of these specimens arises from their having been imbedded in a matrix—not of Limestone, but of a mixture of Sand and Clay; from which they can be detached without difficulty, presenting, when thus freed, an aspect which seems to differ very little from that by which they were characterized when living. Those who are acquainted with the difference in condition between the *Nummulites* of the Bracklesham Clay, and those whose aggregation makes up the purely calcareous beds of the Nummulitic Limestone of Southern Europe, will at once understand the importance of the character of the matrix, when the question is one of minute texture. My own early investigations into the structure of *Nummulites** were fortunately made upon Bracklesham specimens, kindly placed in my hands by Dr. Bowerbank. Had I commenced with studying sections of Nummulitic Limestone, I might have worked long and toilsomely without discovering the fine tubulation, the traces of which, in Nummulites imbedded in a calcareous matrix, are usually almost extinguished by metamorphic action.

The Iowa specimens of *Fusulina* came from two localities, about forty miles apart, but on the same Geological horizon; and they form two series very distinct from each other, alike in size and in complexity of structure. That this difference (which is comparable to that which I have pointed out between the Simple and the Complex types of *Orbitolite*) is *not* one of *Age*, seems very clear from the fact that all the *large* and *complex* specimens come from one locality, and all the *small* and *simple* forms from the other. And I cannot help thinking that the results of the researches on which I have lately been engaged, as to the diverse Temperatures met with on the same sea-bottom at corresponding depths within a few miles, throw considerable light upon cases of this kind, which, when the attention of Palæontologists is once directed to them, may prove by no means unfrequent.

The general structure of the small and *simple* type, of which the largest specimens are about 0·18 inch in length and 0·05 inch in diameter, corresponds so closely with that of the simple type of which internal casts were figured by Prof. Ehrenberg † under the designation *Borelis*, that there is no occasion for me here to say

* 'Quarterly Journal of the Geological Society,' vol. vi. (1849), p. 22.

† 'Mikrogeologie,' plate 37, fig. xi. See also 'Introduction to the Study of the Foraminifera,' plate xii., fig. 24.

more in regard to it, than that it may be likened to a Nummuline or a symmetrical Rotaline, of which the "alar prolongations" extend themselves on either side in lines parallel with each other and with the axis of the spire, instead of folding in towards each other, as they do in discoidal shells. And in regard to the general structure of the large and *complex* type, of which the largest specimens are about 0·30 inch in length and 0·15 inch in diameter, I have nothing to add to the description elsewhere given (*op. cit.*); except that the irregularities which are noticeable in *sections* made either longitudinally or transversely through the terminal portions of the shell, seem explained by the disposition of the alar prolongations which is revealed by *fracture;* for this shows that the alar prolongations, as they pass to a distance from the median plane, tend to interdigitate with each other, in such a manner as to produce great apparent confusion when they are brought into view by section.

It is, however, of the *minute texture* of the shell, that I have especially to speak. This is generally much better preserved in the Iowa specimens, than in specimens imbedded in a Calcareous matrix; but it is still often obscured by metamorphic action, the calcareous infiltration which has penetrated the cavities of these shells throughout, having also filled up the tubuli of their walls, and so blended with the parietes of these tubuli that the line of demarcation between them is by no means distinct. Specimens occur here and there, however, in which the shell-structure has been so little altered, that the diameter of the tubuli, as well as their distance from each other, can be accurately measured (Plate XLV., Fig. 6); and I find their average diameter to be about 1-2500th of an inch, and their distance from one another to be equal to their diameter. Thus they are intermediate in both respects between the *Rotalines* and the *Nummulines;* approaching much more nearly, however, to the former, whose tubuli are commonly about 1-2000th of an inch in diameter, and somewhat more than that apart from each other, than they do to the latter, in which the average diameter of the tubuli does not exceed 1-10,000th of an inch, their distance from each other not being much greater. *Fusulina* departs, however, from the typical *Rotalines,* while it corresponds with the typical *Nummulines,* in the perfect bilateral symmetry of its form, and in the position of the aperture on the median plane; thus adding another to the cases now accumulating in great numbers, in which an earlier type presents a combination of characters which in later periods are distributed among several.* This combination I have shown to be especially characteristic of *Eozöon;* the organic character of which I have now the satisfaction of finding all but universally admitted.

* See 'Principles of General and Comparative Physiology,' 4th ed. (1854), §§ 84–87.

III.—*On the Comparative Steadiness of the Ross and the Jackson Microscope-stands.* By W. B. Carpenter, M.D., F.R.S.

(*Read before the* Royal Microscopical Society, *March* 9, 1870.)

In most of the older Microscopes the *Body* was a fixture, and the focal adjustment was obtained by giving motion to the Stage. This plan, however, was very soon abandoned when the improvement of the Microscope, in its Mechanical as well as its Optical arrangements, was seriously taken in hand by men of real constructive ability; and the *Stage* being made a fixture, two different modes were adopted for supporting and giving motion to the Body, of one or the other of which nearly all the different patterns devised by our now numerous Makers may be regarded as modifications. The one in which the Body is attached at its base only to a transverse Arm, borne on the summit of a racked Stem, I have elsewhere termed the *Ross model;* not because Mr. Ross could in any sense be considered its inventor, but merely because he was among the first to employ it, and his original patterns are now in general use with extremely little modification. The other, in which the Body, having the rack attached to it, is supported for a great part of its length on a sold Limb, to the lower part of which the Stage is fixed, may with more propriety be distinguished as the *Jackson* model;* since it was originally devised by Mr. Jackson, and was thenceforth almost uniformly adopted by the Firm which may be considered as the representative of his ideas.

It has always appeared to me that the Jackson model is so obviously preferable *mechanically*, that if it had been introduced before the Ross model had come into use, it would have been the one more generally adopted; and having lately had an opportunity of comparing the performance of two instruments, one constructed on the Ross and the other on the Jackson model, under peculiarly trying circumstances, and having found my previous opinion most fully confirmed, I have thought it well to bring my experience in this matter before those whom it most especially concerns, namely, Microscope-Makers and practical Microscopists. In order that the bearing of that experience may be rightly understood, it will be desirable in the first instance to examine the conditions on which *tremor* of the Microscopic image depends.

When the building in which the Microscopist is at work is thrown into vibration as a whole, as by the passage of a heavily-laden cart in the street outside,—or the floor of the room in which he is seated is made to vibrate by the tread of a person crossing it,—the Microscope and the observer move together; and if the frame

* In the last edition of my 'Microscope' I inadvertently designated this as the *Lister* model, having supposed it to have been devised by Mr. J. J. Lister.

of the Microscope were *perfectly rigid*, there would be no tremor of the image. For this tremor is the result, not of the vibration of the Microscope as a whole, but either (1) of the difference between the vibration of the Body as a whole and that of the object on the Stage; or (2) of the difference between the vibration of the two extremities of the Body, the ocular and the objective.

Now it scarcely seems to me possible to conceive a method of construction which should be more favourable to this *differential* vibration, especially at the ocular end of the Body, than that which is adopted in the Ross model. The long tubular body, fixed only at its base, is peculiarly subject to it; and although the oblique stays with which it is sometimes furnished diminish the vibration of the tube, they by no means prevent it. The transverse arm and the stem which bears it, each have a vibration of their own; and it is obvious that the nearer to the fixed point of the whole system—which, in this arrangement, is the part of the racked Stem embraced by the tube that carries the Stage—the flexure takes place, the greater will be the vibration of the Eye-piece, which is at the greatest distance from that fixed point. The only mode in which this vibration can be kept in check, is the giving great solidity to the Stem, the Arm, and the Body, especially the two former; and this, while objectionable on account of the cumbrousness which it imparts to the Microscope-stand, is by no means effectual for its purpose; as every Microscopist knows to his cost, when using very high powers under any condition but that of the most perfect stillness of the support.

On the other hand, in the Jackson model, the support of the Body along a great part of its length reduces to a minimum the vibration of the tube, and the consequent differential vibration of the eye-piece; and even in those modifications of it in which the tube has but a short bearing, as the support is given to it in the middle of its length, instead of at its lower extremity, the vibration equally affects its ocular and its objective extremities. The form of the Limb makes the Body much less liable to vibration as a whole, than when supported on the transverse Arm and vertical Stem of the Ross model; and as there is no fixed point from which such vibration can commence, increasing in extent with the distance from that point, the Body and Stage are much more likely to move together, such motion imparting no tremor to the image.

In the 'Porcupine' Expedition for the Exploration of the Deep Sea, in which I took part last summer, microscopic inquiry had to be carried on under conditions very different from those which obtain on shore. When our ship was lying-to under sail, even if the swell was sufficient to produce considerable pitching and rolling, the motion, being imparted equally to the Microscope as a whole and to the Observer, did not produce any tremor of the image; and the only difficulty lay in the maintenance of the observer's own position, which was most effectually secured by firmly grasping the leg of the table (which was fixed to the floor of the cabin) between his knees. When the ship was going under "easy steam," with either a fair wind or a light contrary breeze, there was enough *general* vibration to produce a considerable *differential* vibration in any Microscope liable to it, and thus to occasion a decided tremor in the image even when only moderate powers were employed. But when we were steaming with full power against a head-sea, the general vibration became so great as to be the severest test of the mechanical arrangements of our Microscopes. Now, it happened that whilst my own instrument—a portable Binocular Microscope weighing *less than seven pounds*, which is my usual travelling companion—is constructed on the Jackson model, Professor Wyville Thomson was provided with an instrument of about the same scale, but heavier by some pounds, made upon the Ross model; and we thus had an opportunity of fairly testing the two plans of construction under circumstances peculiarly critical. The difference in their performance was even more remarkable than I had anticipated. I found that I could use a 1-4th-inch objective on my own Microscope, with an even greater freedom from tremor in the image than I could use a 2-3rds-inch objective on Professor Wyville Thomson's. In fact the image "danced" very perceptibly in the latter, even when the $1\frac{1}{2}$-inch objective was in use.

Now I purposely abstain (for obvious reasons) from naming the Makers of these two instruments. But I think it well to say this much, in order to meet the possible objection, that the difference lay rather in the *workmanship* of the two instruments than in their *plan of construction*,—that the advantage, if any, lay on the side of the Ross model. And my own very decided conviction is, that the adoption of the principles of the Jackson model would be decidedly advantageous, alike for *first*-class Microscopes, in which the *steadiness of the image* when the highest powers are being employed ought to be a primary consideration,—for those *second*-class instruments, which are intended, at a less cost, to do as much of the work of the first-class as they can be made to perform, *portability* being here of essential importance,—and for those *third*-class instruments in which everything has to be reduced to its simplest form, so as to permit the greatest reduction in their cost.

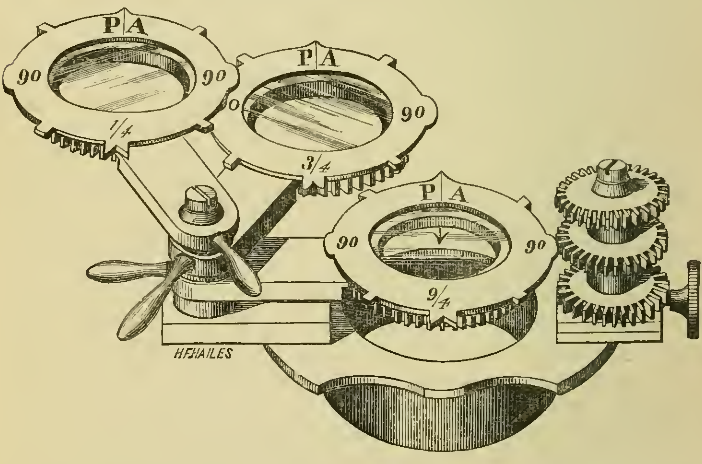
IV.—*A New Method of using Darker's Films.*

By Edward Richards.

(*Read before the* Royal Microscopical Society, *March* 9, 1870.)

I am desirous of bringing before the notice of the Society a new and more exact method of working with Darker's Films of Selenite.

The instrument consists of three cells of brass cut out on the edge so as to leave eight projections, two of which resemble the end of an arrow denoting the positive axis, two semicircular at right angles denoting 90°, and four smaller which stand for 45°, which as signs cannot be mistaken; and are rotated in three separate arms while under a polarizing microscope; and if the Selenite films are turned round till their positive axes coincide they give the sum of their combined retardation.



If any be turned till their positive axes are at 90°, or the semicircular projections to the positive axis or arrow-head of the others, the lesser number is subtracted from the greater.

For instance when the positive axis of the $\frac{3}{4}$ths is placed at right angles to the positive axis of the $\frac{9}{4}$ths, the sum of the difference only is obtained $= \frac{6}{4}$ths.

If the $\frac{1}{4}$th is now added with its positive axis coinciding with the positive axis of the $\frac{9}{4}$ths, seven quarters are obtained; but if placed to coincide with the positive axis of the $\frac{3}{4}$ths, five quarters is the result.

Therefore, by subtracting by the semicircular projection or adding by the arrow-head any number from $\frac{1}{4}$th to $\frac{13}{4}$ths, undulations can be retarded, which include all the colours of the spectrum; and I think the simplicity of this arrangement will be self-evident to all.

I do not know of any method in which the number of quarters in use can be seen so plainly as in this: it is no use to have thirteen quarters in the Selenite films unless we can have them under command, to know what suits our object best. Messrs. Beck's arrangement is well suited for this form of cell (*which I think is all that is necessary*), and the achromatic condenser can be used without difficulty. But in almost all the new methods of late, toothed wheels have played an important part; and I have added six to mine, the object of which is to rotate any number of quarters simultaneously. They are put in gear by a small milled head at the side.

The instrument, including the cutting of the teeth of the wheels, having been done by me (an amateur), it will be a sufficient apology for the way in which the brasswork is finished.

V.—*A New Tube-dwelling Stentor.*

By Charles A. Barrett, M.R.C.S. Eng., F.R.M.S.

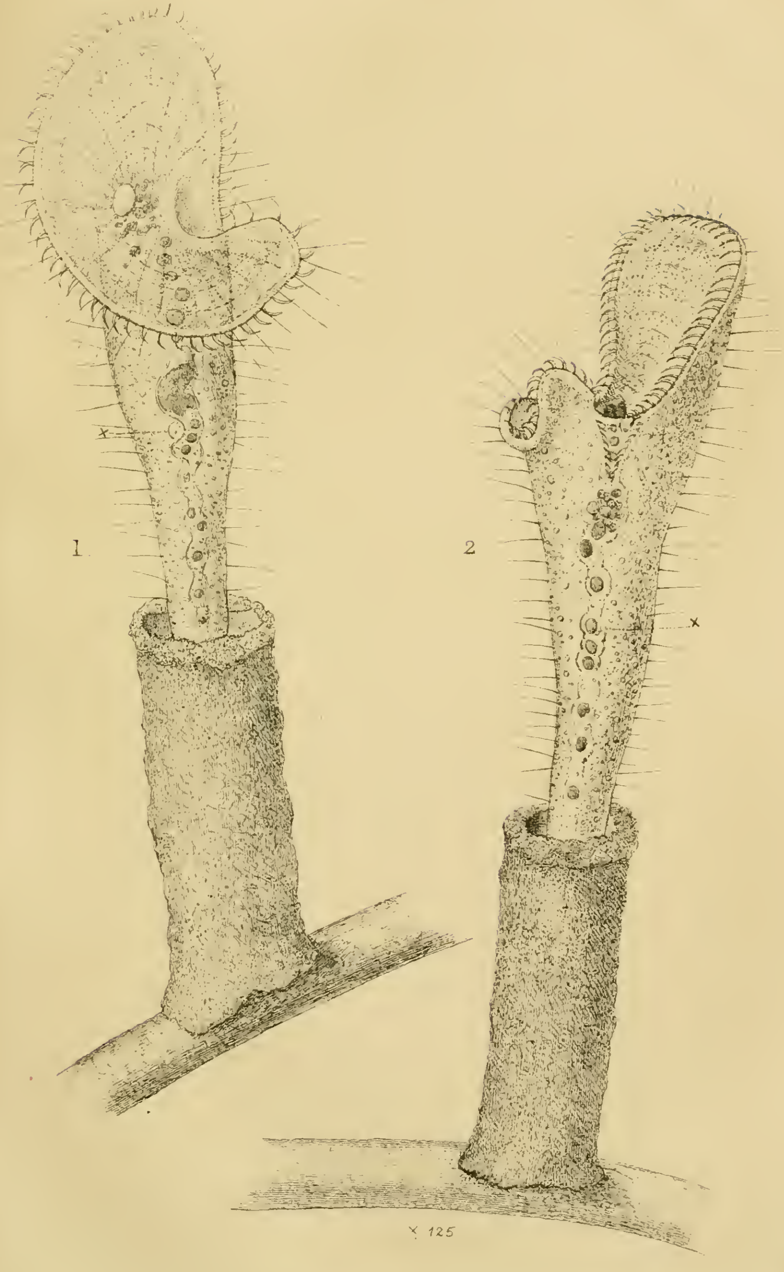
(*Read before the* Royal Microscopical Society, *March* 9, 1870.)

Plate XLVI.

In the autumn of 1867 I found on a piece of weed, taken from the Thames at Moulsford, the animalcule that forms the subject of this paper.

I was looking for Lagotia, which I had found before on weed from the above locality (though Pritchard quotes Lagotia as a marine animal). When I first saw the upper part of the expanded head, just showing above the piece of weed, I thought it was one of the lappets of the head of the animal I was in search of, but found when it was quite extended that it was a stentor-like animal quite new to me.

I turned the weed over to have a better view of it, and found that it was inhabiting a case or tube. The creature was a young specimen, and the tube was but slightly transparent. In older specimens it becomes opaque. The case was of a light brown colour, firm in consistence between that of the tubes of the Limnias and Tubicularia, well formed and gelatinous. The form of the creature could be just made out, but with difficulty. It was retracted, and was of an ovoid shape at the bottom of its tube. After waiting a short time, it extended itself, and was then a most magnificent-looking animal. It was trumpet-shaped, having no division between the body and that part within the case. It was filled with a bluish-white sarcode, granular and having many vacuoles ; the head when expanded was large, and shaped like the human ear. Just within the edge of this was a thin membrane running round, at the edge of which were placed the vibrating cilia. This thin membrane I shall call the velum. These cilia were in active motion, and produced a current that brought food, &c., from a comparatively long distance to the animal's mouth. There were no cilia over the body, but standing at right angles to the body, and at equal distances from each other, there were long fine hairs. These hairs were five or six times the length of the cilia on the velum, and were perfectly motionless. In fact, though I had the creature under examination for a long time, and daily, I never saw them flash even, like the setæ of the Floscularia and Stephanoceros do. These hairs were in appearance like the setæ of the Floscularia, and much added to the beauty of the creature. These I shall call setæ. These setæ were also placed round the edge of the ear-shaped head, but on a plane external to the velum. From the centre of the expanded head were radiating lines or fibres. These were again interlaced with other



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Mr. Barrett's new Stentor

lines running round parallel to the velum, giving it the appearance of fine basket-work. I examined the animal very carefully, with carmine in the water and oblique illumination, using a power of 500 diameters, to see if I could see any cilia clothing the body of the creature, like there always are on the body of the stentor, but I failed to find any. The velum bearing the cilia may be said to begin at the perpendicular part of the disc, near the mouth, and running round the inside of the edge, continues uninterruptedly till it reaches the same place again. From here two short processes are sent towards the centre of the disc, and in this grove is situated the mouth, and I think the anal opening. These processes are edged with vibrating cilia. The mouth is funnel-shaped, lined with cilia, and leading down to a short œsophagus. It is situated on the left side of the disc, in the place the mouth of all this class of creatures is. Below the œsophagus are a series of vacuoles, which become very apparent when the animal is fed with carmine. The two or three upper ones are small. Then there is a large one, looking very like a stomach. Below this, even into the part within the case, is a row of small ones, and some others leading up to the cloaca which is in the centre of the disc. Close to this cloaca, and not far from the mouth, is an oval-shaped body, having two fine branches leading down the whole length of the body, one on either side of the vacuoles containing food, giving them the appearance of being enclosed within an intestine. It also sends a branch to the mouth, and another to the ciliary edge of the disc. This latter branch runs all round the edge. I think from its position, which is the same as that of the nervous ganglion of the Polyzoa, that this must be the nervous ganglion of this animal. It has the grey look of nervous matter. That an animal having the power of protecting itself within a case, and retracting readily on a jar being given to the microscope stand or table, should have, and should require a kind of nervous system is not much to be wondered at. This animal being larger than the generality of these creatures, it can be seen, whilst in many of them it cannot. In front of the large stomach-like mass are three clear vacuoles that did not become filled with the carmine, or even stained with it. What their office is I could not find out. On either side of the same mass was a contractile vesicle. The appearance of the expanded head of the animal, when it has its oral side towards you, is most extraordinary, putting one in mind of those old arm-chairs seen in the halls of large houses, for the waiting-door porter to sit in. Fig. 2 is the animal in that position, and it shows in side view the shape of the expanded disc. The back is carried straight up in continuation of the body; but the front lobe is bent down, showing an expanded surface round which the ever-moving cilia play. Fig. 1 is a front view of the creature, and in that the peculiar ear-shaped disc is seen. I saw a young one either come from behind, or else out of a tube inhabited by an old specimen. It swam away so fast that I had not the power of making a sketch of it. It was like a small stentor or a young tubicularia. I have compared it to these two, for the stentor, when free swimming, takes so many forms.

My reasons for thinking the above animal is a stentor is its general configuration, its having no trace of an alimentary canal, and the total absence of a masticatory apparatus, there being not any division in the body like there is in all the rotatoria, between body and foot stalk, and its being filled with a granular sarcode, containing vacuoles, like all the family of Vorticellina. The only difficulty in the matter is, that, as a stentor, it ought to be clothed with cilia, which these long hairs on this animal can hardly represent, for they are not thickly placed, they stand erect and at a distance from each other; and they are not vibrating. It is different to the Stentor Mulleri in many ways: besides the absence of cilia over the body, the disc is carried by this creature in a more erect position, perpendicular to the body, whilst in S. Mulleri it is horizontal to it, and the shape of the expanded disc is very different. The tube is in this creature a well-made, regular tube, and is opaque when old. In S. Mulleri it is floculent and transparent even when stained with the fœcal discharges of the animal. That this animal is not a wanderer that has taken possession of the case of another animal is shown by their being social in their habits, and it would be extraordinary that they should find a colony of tubes ready for them when required. Then, again, the case is well made and fits its possessor, which would not be the case if it were borrowed.

I have found this animalcule for three years in the same place, from the end of summer to as long as any weed lasts in the river at that place. It is on the north side of a wall built into the river Thames, overhung by elms, therefore it is always in the shade. This is just above Moulsford Ferry. They are always the same, showing them to be, I think, animals *sui generis*. I will draw the distinctive characters up as follows:—

The animal lives attached by the lower portion of its body within a tubular case, which is firm, of a light brown colour when young, slightly transparent, becoming opaque and of a darker colour with age. The animal is trumpet-shaped when extended, ovoid when contracted. The body is covered with long hairs, standing erect from it, and continued round the expanded head, on a plane, external to the cilia, which are placed on the free edge of the velum, which runs round within the edge of the ear-shaped disc. Where the perpendicular portion is joined by the lower portion on the left side two ciliated processes are sent to the centre of the head, and between these the mouth, which is funnel-shaped, is placed, and I think the anal opening. The mouth is lined with vibrating cilia, and leads down to the stomach sacs through a short œsophagus. Close to the cloaca and near the mouth is placed what I take to be the nervous ganglion. It is oval-shaped, sends down two branches the whole length of the body, one branch to the mouth and one round the ciliated head. The body is composed of a semi-transparent bluish-white granular sarcode, enclosing many vacuoles; the contractile vesicles are placed one on either side of the largest stomach sac. The body has no division between it and a tail-like foot-stalk, and it has neither masticatory bulb nor teeth, both of which are present in tube-dwelling rotifers. The length of the case is $\frac{1}{50}$th, and of the extended animal $\frac{1}{25}$th of an inch.

I have shown the animalcule and the accompanying drawing to many of my microscopical friends, and have called it provisionally "Stentor Barretti," until a proper name and place has been assigned to it.

VI.—*Further Remarks on High-power Definition.** By Royston-Pigott, M.A., M.D., M.R.C.P., F.R.A.S., F.R.M.S., formerly Fellow of St. Peter's College, Cambridge.

No. II.

Doubtless there is a new field of observation opening to microscopists with the improved magnifying power of modern glasses. There is one point in particular to which I beg to direct the attention of the Society as worthy of closer investigation, for in it lies the germ of great advances in accuracy of definition,—it is the focal image of minute lenses or beading. I arrived at this conclusion lately from the following observation:—The image for parallel rays lying nearly one-fourth of a diameter outside the surface of a refracting spherule, it occurred to me that perhaps it might be possible to form a diatom-lenticular image by selecting beading sufficiently large, and under this impression I now placed a black bar half an inch broad and six inches distant from a diatom, so as to intercept some of the light reflected from an ordinary mirror. After several trials and searching for a focal point above the surface of the beading, I was rewarded for the first time with a bar-image, which could be made to gyrate or oscillate according to the movement of the bar; and subsequently I formed an oval image of the mirror itself, which also moved from side to side in the *same direction* as the motion of the mirror. This is a perfect and unlooked-for demonstration of the *convexity* of the beaded surface. The shadow test of sphericity alluded to in my paper of last year as *crescentic*, or rather crescent-like, was conclusive; as only a spherical surface could give symmetrical curvilinear shadows. But the position of the image, without and above, the focus, at once settles the beaded question. The prophecy might almost be ventured that the time is coming when the images formed by lenticular beads in diatoms will furnish the most exquisite test known for correcting and verifying microscopical definition under high powers. The image was detected with a Wray $\frac{1}{5}$th of excellent quality.

Already these beautiful objects may be regarded as a mass of highly-refracting spherules.†

Like a fairy rainbow of infinitesimal drops of solidified silica, their play of colours is remarkable in the extreme. Doubtless,

* Dr. Pigott wishes us to state that this article was received by us on the 11th of March.—Ed. M. M. J.

† I may be allowed to add that I had the good fortune to discover yesterday that the median line of the Formosum is formed of four parallel rows of beads, about one-third the size of the general beading. Every part seems compounded of cohesive spherules.

besides the focal images of the Formosa and Angulata beading, there emanates a rich bundle of iridescent rays from all these wonderful little siliceous gems; small though they be, they are huge compared with the wavelets that play around and within them. As the falling drop refracts the sunbeam, reflects it twice internally before returning it to the outer air and changes its colours simply by new deflections, so the diatom beading plays with the ethereal particles, dispersing its spreading rays in full prismatic glory. Yet these colours, so evident even to the unassisted sight *en masse*, vanish in *achromatic vision!* Should then these charming characters be destroyed? Dechromation of Nature's own colours resplendent in beauty is a chromatic crime.

The colouring of many objects is more exquisite and fascinating as the perfection of high-power definition advances. We have a wonderful example of this in the recently-discovered colouring of Jupiter's disk, which can never be as well seen by *achromatic*—artificially achromatic glasses—as by the non-chromatic mirrors. I have lately seen the Formosum beading coloured with red, orange, yellow, and blue. The beading has appeared wreathed with a golden bronzing. Individual beads separated from their fellows have appeared remarkably distinct. Destruction of colour reduces the field to a spiritless picture. Objects which ought to be and, in some cases, can be, lit up with a startling brilliance of hue, regain with altered corrections the tame colouring of a dull prevailing yellow and black. There is something recondite here beyond our ken, to be patiently searched and understood.

The focal image of a brilliant flame may be distinguished just above a spherical bead, in general only as a *round* disk. All change in the shape of the flame is useless. The brilliant focal disk may be found *just above* the surface of the bead. But I have observed this singularity about it, that it expands the bead into an abnormal size. Thus in observing the Podura beadings which are excessively transparent and refractive, wherever a bead (considered as a refracting lens) is so situated among the crossing rouleaus that its full aperture allows a brilliant focal point to be formed (according to the direction of the illuminating ray), there, it acquires nearly double its real size and an exaggerated importance, and of course tells a delusive tale.

It is probable that the Diatom beading I now beg to urge our Fellows to examine, will finally give up the focal images, of a black cross (say a Maltese one), to an aperture varying from *sixty to ninety degrees according to the refractive index of the siliceous spherules themselves.* It can be readily demonstrated that aperture has a peculiar effect upon the action and reactions (if I may so speak) of refracting particles upon the light and pencils introduced to the eye of the observer by the observing objective. I would just remark that the focal images of convex lenses being inverted twice, will give a direct motion in the microscope from right to left when the object is moved from right to left. As an encouraging practising to those who desire to accomplish this microscopical feat for themselves, I beg to recommend the preliminary use of well-mounted *Beetles-eyes*, in which the images can be well studied. Precisely analogous effects in every respect may be looked for, in the convex spherical refracting surfaces of diatoms. When the lens is concave or double concave, the image I find by calculation lies beneath the ordinary surface.

VII.—*A Contribution to the Teratology of Infusoria.*

By J. G. Tatem.

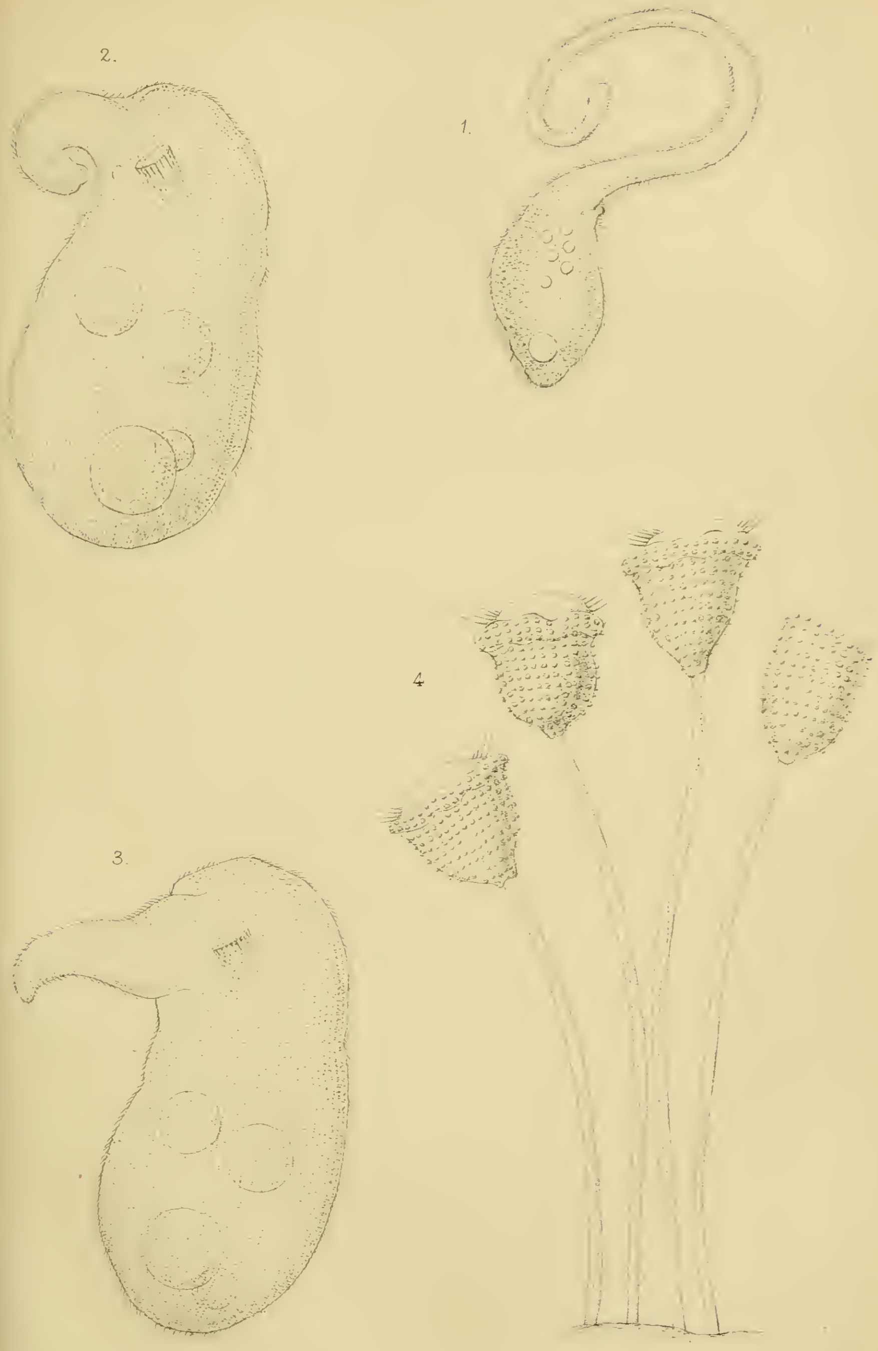
Plates XLVII. and XLVIII..

It is sufficiently well known that the ciliated Infusoria, under like phases of existence, maintain in each species a definite and constant outline, and that differences of size or of colour, consequent on the injection of food varying in quantity and character, are all which distinguish one individual from another. These precise and fixed forms are, however, occasionally, though rarely, departed from; and we meet with examples of malformation, dependent in these, as in all other such cases, on hypertrophy or on arrest of development. Of the few such instances as have from time to time come under my observation I made careful drawings, and these I now beg to submit to your examination.

In Fig. 1 we have a *Trachelias anas*, in which the lip, or brow (as it is sometimes called), is inordinately prolonged, somewhat spirally coiled, and clothed with longer and stouter cilia than usual.

In Figs. 2 and 3, a *Chilodon cucullulus*, we have also a monstrous development of the same part, the lip projecting into an elongated proboscis-like appendage, which, as seen waving to and fro, and twisting with every movement of the animal, presented a singularly grotesque appearance.

In contrast with the two preceding is a charming *Vorticella*, Fig. 4. Elegant and attractive as are the several species of *Vorticellæ*, it surpasses them all in beauty, and it is with reluctance only that we can be brought to regard it as a monstrosity. Met with on several occasions and in widely distant localities, we may fairly question if it may not rather claim the importance of a named variety, under that of *Vorticella convallaria*, var. *monilata*. I have always entertained the opinion, though unable to assure myself of the fact, that the transverse striations on the body of *Vorticella con-*



Tuffen West sc W West imp

Teratology of Infusoria.

5.

6.

Tuffen West sc. W West imp.

vallaria, like the markings of a *Pleurosigma*, are composed of closely dotted, very minute, bead-like elevations of the surface, and certainly the idea gains some colour from the example before us. In it we find large transparent highly refractive beads, arranged circularly in equidistant rows on the body of the animal. May we not therefore infer that, diminished in number, but exaggerated in size, we have the striations of *Vorticella convallaria* made apparent? However this may be, no more striking object for microscopical observation can be found in the whole range of Infusorial life than is presented by a group of these exceedingly beautiful animalcules.

If these deviations from regular outline in ciliated Infusoria are resultant on hypertrophy, arrest of development principally operates in effecting such changes in the Rotifera—the *Tubicolæ* being apparently most subject to them. In Melicerta, through successive degradations and the suppression of parts, several varieties are produced, which have been commented upon elsewhere. The *Stephanoceros Eichornii* here figured (5 and 6) presents, however, a generally stunted and abortive growth. Instead of the graceful amphora-like form, surmounted by a crown of elegantly incurved tenacula, bordered by verticils of setæ, we have a short squab body, planted on an equally short, much corrugated foot, a narrow, though deep infundibulum, supporting five short, obtuse lobes, clothed with rows of long setæ, and altogether comparing very unfavourably in appearance with the Stephanoceri obtained from the same locality.

Malformations such as those I have cited have, in my opinion, a value beyond that of mere curiosities, though as such they would be worthy of notice and record; for may they not help to determine the fixity or otherwise of a species through aberrant forms? and thus a better knowledge of what is to be regarded as essentially specific be ultimately arrived at.—*A paper read before the Reading Microscopical Society, February 15th.*

VIII.—*The Polymorphic Character of the Products of Development of Monas Lens.*

By Metcalfe Johnson, M.R.C.S.E.

In the August number of the 'Monthly Microscopical Journal,' Art. VII., it has been pointed out "that the bearing of the facts there recorded upon Speciology, Epidemiology, and Nature Scavenging will be at once evident."

Professor Tyndall has recently called PUBLIC attention to the second point, which has long been the subject of research to scientific men.

Doubtless to his great and well earned fame we shall owe many facts and opinions which will now be given to the world, but have hitherto (like the researches of the alchemists) been confined to the darkness of scientific studios, and transcribed in the cabalistic abracadabra of such investigations.

But now that the subject is no longer caviare to the multitude, it becomes the duty of all who are interested to throw the glimmer of their lanterns (however small) upon the thief that is suspected of such deadly intents and purposes.

The object of the present remarks is to draw attention to Monas Lens and its kindred organisms, as a means of Nature's scavenging; but to review the subjects in the order in which they have been put, a few words must first be directed to Speciology.

The observations of Sir Charles Lyell,* Professor Phillips,† Dr. J. B. Hicks,‡ Mr. Browning,§ and other writers, may be quoted in support of the opinion that "species is merely an abstraction of the human intellect," "not a real boundary set by nature;" and that "from one cell" many developments "can and do arise," and the facts recorded in the "Jottings" give additional colour to this opinion.

The transmutability of one form to another is important to a subsequent consideration of the "Germ" theory of disease; indeed to support the proposition that monads (from various sources) will develop results varying as the "accidents" of their life, the previous opinion that species is an isolated collection of organisms within a definite boundary, must give way to that more extended view which arises from tracing the convergent lines of evidence to their necessary point of incidence.‖

In order to trace the "Germ" to its existence in the air, its source must be examined, and if it is found to arise from plants and (passing through stages varying with surrounding conditions) to be capable of development to forms hitherto considered distinct, the resultant forms (from still more widely differing conditions of pabulum, &c.) will again exhibit variety; and that if water gives one result, air a second, ozone a third, mucilage a fourth, and so on, then the effect of *living* mucous membrane must of necessity be diverse from all. Always bearing in mind the balancing effect of "heredity" and "recurrence."

But now, to address the remarks more especially to Epidemiology and Nature's scavenging.¶ Professor Tyndall has referred to the researches of Pasteur and others, and it may be added that

* 'Antiquity of Man,' p. 389.
† 'Life: its Origin and Succession,' p. 199.
‡ 'Quarterly Journal of Microscopical Science.'
§ 'Monthly Microscopical Journal,' July, 1869.
‖ See "Higher and Lower Animals:" 'Quarterly Review.'
¶ W. A. H. Hassall, Introd., p. 42.

Professor Sigri calls the attention of the French Academy to the presence of Bacteria in the blood in typhus. Dr. Salisbury has shown the connection of a Palmella with intermittent fever; Dr. Lund, of Manchester, has called attention to "Germs" in hospital wards; Professor Lister's valuable researches on Carbolic Acid; the question of Vibrio in Influenza;* Mr. Dancer's paper "On Milk;" Mr. Staniland Wake's observations on Mineral Infusions; Dr. Angus Smith and Mr. Dancer's Bottle experiments, and Mr. Spencer Cobbould's treatise on Entozoa—all bear upon the great subject in question.

Empirical practice always precedes explanation, and the surgery of the day, preserved meat practice, the stillette corking of wine, and the occlusion of "preserves;" have already applied the facts long before the *modus medendi* has been interpreted.

Abundant evidence of the presence of Monas Lens in all liquids containing vegetable matter is found in every investigation, and in the air in varying quantities at different times;† also as having been observed escaping from the primordial utricle of masses of chlorophyll within the tubule into the vacuole in Confervæ; as assuming its own rotatory movement on escaping from the primordial utricle of isolated masses of confervoid growth; as escaping from the bursting tubules of Vaucheria; as passing to forms which are undistinguishable from those recognized as stages of Oscillatoria, &c. For confirmation, see Franz Unger on Vaucheria, Berkley, 'Brit Algæ,' p. 27; Agardh on Conferva Ærea, Harvey, p. xxvii.; A. H. Hassall, Introd., p. 14; and Hicks.‡ In the last case the germs are apparently more developed.§ I have seen full-sized Euglena in the tube of Vaucheria in active motion.

These zoospores of Algæ present an appearance precisely similar to that of Monads found in the air, as also to those found in infusorial researches. The form is similar, their movements are similar, and so far as microscopy at present teaches they are identical. There is much evidence that Mucor Mucedo, Vibrio, and Monas, result from, or, at any rate, are coincident with the presence of more or less air and light, and it would appear that liquids or substances (from which air is entirely excluded) do not develop protozöal growths.

Feb. 6th, 1870.—Examined a bottle containing crushed grass and water, corked, in light, since November 17th, 1869. No signs of moving life.

* My own observations on the nasal discharges in influenza have failed to detect organisms, being constantly obstructed by the formation of crucial crystals of sodic chloride, called by the micro-photographers "crystals of the human breath."

† See "Jottings."

‡ "Gonidia of Mosses:" 'Trans. Lin. Soc.,' p. 581.

§ See "Jottings," Jan., 1870, p. 28. "Observations on the Birth of Euglena," April 11.

Where the quantity of air and light is limited, Mucedinæ arise. Where air is freely and light sparingly admitted, Monas passing to Paramœcium is found; but where air and light are freely applied, Monas passing to Gonidium and Euglena may be expected. In liquids where moisture is diminishing, Oscillatoria seem to arise.

The Soridium of Chlorococcus is white in moist dark holes, as decayed elder trees and moist banks; green in exposed surfaces, and yellow on stone walls, passing either to green with Apothecia or to yellow Thallus and subsequent Apothecia, forming Parmelia parietana; in damp places, as bottoms of palings or doors, Lyngbya results, while in very damp and rather shaded positions, Cladonia pixidata.*

These, with numerous other modifications, as Collema Lecanora, &c., afford infinite evidence of a tendency to variation, of what, by tracing connections aided by microscopical research, would seem to owe their origin to Monas Lens, or some other elementary germ, whose difference is too minute to come within the reach of our present microscopic vision.

It may be observed that Dr. Hicks traces the origin of the lichens, &c., no farther back than Chlorococcus; but with all deference to so close and accurate an observer, it may be suggested that experiments on Monads and their kindred organisms show that they are entitled to further examination as the probable more remote, though possibly (as Professor Beale suggests) by no means the ultimate source of the Protozoa.†

Note.—*Nov.* 30. The lungs of a rabbit, placed in two pints of water in deep glass jar, in dark cupboard ten days; result, Mucor Mucedo. Liver, heart, and kidneys, in two pints of water in glass jar, exposed to light ten days; result, Vibrions, Monads, and Paramœcia.

Professor Tyndall has shown that the rapidity with which air passes through red-hot tubes causes much variation in the amount of organisms and vegetal matter evidenced. This throws light on the dispute beeween Pasteur and Jeffries Wyman. But the vitality of germs is shown to be very tenacious by Vaucher's observations on frozen water.

Attention must also be paid to the pabulum afforded to these organisms; for we find that as ozone is present or absent so does carbonic anhydride vary in evolution. Certain substances prevent, others admit of, while others, again, promote their growth.

Besides the experiments on various liquids, there is evidence, from the varied states of growth which make their appearance on inland stone walls, marine stones, trees, stagnant pools, running water, shallow streams, deep seas (see Bathybius), drainage from

* See Hicks on Chlorococcus, Cladonia, Lyngbya, Nostor, &c.

† Protoplasm, pp. 72, 3.

manure-heaps and dark cesspools, that there are other "choses extérieures" which affect the cell in its future growth and development.

The facts recorded in Parts I. and II., bearing on this subject, will be found as follows:—

Presence of Monas in air.—M. M. J., Aug., 1869, page 100, lines 10, 17, 20, 21; Exp., March 5, 1868; Exp., May 25, 1869. M. M. J., Jan., 1870, page 25, line 21; Exp., July 21.

Monas in Vacuole.—M. M. J., Aug., 1869, page 99, line 27; page 104, line 4.

Escape of Monas from Chlorophyll blastoderm.—M. M. J., Jan., 1870, page 25, line 17.

In November, 1867, I witnessed under a power of 700, round masses of chlorophyll enclosed within a transparent primordial utricle. I saw the utricle burst, and small transparent bodies, having the appearance of Monas, escape into the surrounding fluid, and at once assume their own rotatory movement.

Development of Monas to Paramœcium.—M. M. J., Aug., 1869, page 101, lines 1, 2, 8, 9, 11, 12, 13; p. 102, lines 40, 42; page 103, line 2.

Monas to Gonidium, Euglena, and Chlorococcus.—M. M. J., Aug., 1869; Exp., March 5, 1868, *e. g.* M. M. J., Jan., 1870; Exp., July 21, 1869.

Development of Mucedo.—M. M. J., Aug., 1869; Exp., March 5, 1868; *b.* Exp., May 25, 1868; B, C, D, G, and Exp., Nov. 30, 1869.

An interesting series of experiments might lead to more certain results did time permit; but the occupations of an active professional life leave little leisure for more than desultory observations. Thus experiments on *results* from air (passed through cotton wool) (series of Woulfe's bottles of potassic permanganate, &c.) to organic solutions previously ascertained to be free from living organisms would show how far the previous experiments are free from suspicion or worthy of reliance.

The opinion that the organisms of this class (the dyalizers, so to speak) have the power to change non-vitalized to vitalized matter is supported by Mr. Hassall * and Mr. Browning.† It would seem then that the condition of organized matter known as dead requires an agent to convert it into the opposite condition known as living. This is shown in the decomposition of organic matter, in which one or other of these protozöal forms seems to play the part of intermurciator, and in the case of disease where cells are passed from life to death, this all-pervading "minister of health or goblin damned" is ever ready to effect the process. It may, therefore, not inaptly be termed Nature's scavenger; and while certain con-

* Introd., p. 42. † 'Monthly Microscopical Journal,' July, 1869.

ditions of the vital economy, known as "low vitality," seem requisite to permit of the *de*structive change in the dead cell by the *con*structive change in the dyalizer. Evidence is everywhere abundant that such changes can and do take place. Observation shows us that plants in perfect health do not develop their parasites; that vigorous leaves are not the nidus for the growth of lichens; that even between living and dead bark of trees the character of the protozöal growth differs, therefore we may conclude that the parallel condition of health in animals is associated with the power to resist destructive change of which Monas and its congeners are the dyalizers. In this sense, then, it is interesting to observe the relation of ozone to disease, and if we consider the chemical changes in atmosphere, and the true nature of ozone, we shall at once become aware of an apparent *ratio operandi*.

In reply to a letter which I wrote to him in September, 1866, the late Mr. Samuel Marshall, of Kendal (for many years a close observer of ozone), writes as follows:—

"In reply to thy query, 'Have you any evidence as to its (ozone) relation to health and disease?' This was the chief motive for these observations. By consulting three or four of our medical men, we have all long seen a manifest connection. My observations corroborate the following conclusion of Dr. Moffatt, who in a letter to me says, 'Maximum of *disease* occurs with the *maximum* of ozone, and *vice versâ*. The *maximum* of deaths takes place with the *minimum* of ozone.' It will probably interest thee to find that, in the last four months of 1865, we had a fever of a low typhoid cast, and this continued on the first month of 1866. In the second (month) it began to decline. In the last four months of 1865 the mean quantity of ozone was very low; but it has gradually increased, and the town become very healthy."

Schönbein says, "Air containing $\frac{1}{6000}$ of ozone can disinfect 540 times its volume of air produced from highly putrid meat."

What is this disinfecting? Is it not most probably the absorption of odorous gases by the Monads of the air which dyalize the ozone and the odorous gas? *

It will be evident to all who have observed the action of ozone on dead animal tissues, that it is very easily destroyed. I have made use of bladders to transfer it from one vessel to another, but always found that the contact with the animal membrane at once removed all traces of the ozone.

Professor Tyndall has referred to the large particles of dust which scintillate in a sunbeam as a cause of disease. These, as shown by Pasteur, Pouchet, and others, as well as by my own ob-

* See "Experiments on Yeast," 'Monthly Microscopical Journal,' Aug., 1868, p. 100.

servations,* consist of angular masses of silex, soot flakes, pollen, grains, starch granules, ligneous particles, Gonidia, Soridia, linen cotton, and woollen fibres, hairs, &c., and may become traumatic causes of disease, and give rise to bronchitis, influenza, knife-grinders' and stonemasons' asthma, as well as the bronchitis and consumption of cabinet makers, moulders, sweeps, and cotton operatives; but not the critical diseases known as fever, rubeola, scarlatina, &c., which so resemble the growth of living beings in their *birth, perfection,* and *decay.*

Time will not admit of the consideration of the multitude of questions which evolve themselves out of this series of observations: such as Monas and its congeners as the source of Infusoria and protozöal growths; granular matter of Paramœcium as consisting of Monads (evidence seems, however, to show that it is so of chlorophyll); the relation Monas has to Vibrio and to Mucor, or Vibrio to Mucor, or Bacterium to Vibrio†—the nucleus theory; the contraction of cell-wall as a source of cilia; the shape of cells; the change of colour in cells; the conjugation of cells as a Gamic process; the vitality of formed matter;‡ volition as the cause of life;§ nutrition by Dyalysis; Amœba as highly organized when compared with Monas; the relation of granular Mucor to Pus, and the series of relations between Chlorococcus and Lichen and Moss growths, between Palmella cruenta and Oscillatoria, Oscillatoria and Lyngbya, Lyngbya and Moss; the relation of Paramœcia to Convallaria, Callidina elegans, Actinophyris Sol, &c., and even the relation of Diatoms to Algæ.|| These and numerous other interesting questions, of which evidence will be found in the "Jottings," must give place to that of the relation of Monas to the great formative and destructive changes of life, called health and disease. Evidence on this point, involving as it does all these other considerations, and many more must of necessity at its onset be very meagre and inconclusive. The facts, so far as they go, warrant a further investigation; suffice it to say that this great subject of world-wide importance cannot be elucidated with the rapidity that is desirable by the efforts of private individuals, even though they bring the talents and unwearied zeal of a Tyndall, a Beale, an Owen, or a Huxley to the rescue; but it is not only worthy of a State department, but can only be elaborated by the extended experience of large bodies of special investigators.

Under this view, Monas and its congeners become at once im-

* See "Jottings," Aug., 1869, p. 101; Exp., March 6, line 43.

† See 'Fran Luders Botanisch Zeitung.' 1866.

‡ Beale, pp. 69, 70. § Ibid., p. 156.

|| In reference to a source of fallacy in microscopic experiments on motion as a sign of "life," and its relation to the chemico-vital process of nutrition, it may be observed that the movements of a piece of sodium on water, when in a state of ignition, very closely resemble those of Monas in some of its forms.

portant as agents in removing dead cells, and in their place supplying us with the green verdure which is springing up around us on every side, affording in their death, like Mondamin (Hiawatha) the pabulum whence the higher vegetal life arises, which in its turn ministers to the wants of herbivora, carnivora, and man. A nobler theme can hardly occupy our thoughts, a higher subject can hardly stimulate our labours, and we can only say with our great Laureate:—

"The sun, the moon, and the stars, the sea, the hills, and the plains,
Are not these, O soul! the vision of Him who reigns?
The ear of man cannot hear, and the eye of man cannot see;
But if we could see and hear this vision—were it not HE."

PROGRESS OF MICROSCOPICAL SCIENCE.

The Peculiar Out-growths of Bridgesia Spicata.—At the meeting of the Scientific Committee of the Royal Horticultural Society, on the 2nd of March, Dr. Maxwell T. Masters reported on the above structures as follows :—" The peculiar out-growths of this plant are protruded from the young shoots above the axils of the leaves, and above the branch proceeding therefrom. In the fully developed state they are about the size of a large pea, of a yellowish colour, and have a general resemblance to the tufts of hair found in similar situations in Pereskia. In the youngest condition the excrescences occur in the form of small, smooth, conical projections, covered with an outer layer of small oblong cells, the outer walls of which are thickened; subjacent to these are four or five rows of small, spheroidal, densely-packed cells, also cortical in their nature. These overlie a mass of ordinary cellular tissue, the cells of which contain chlorophyll. Running into this conical cellular projection are two rows of small spiral vessels, which converge towards the apex of the cone, and form a loop. These spiral vessels are continuous with those of the vascular circle of the branch, and are surrounded on all sides by oblong thin-walled cells, whose long diameter is parallel to that of the spiral vessels, and more or less at right angles to the direction of the parenchymatous tissue of the cortex and also of the medulla. The constituent cells of the medulla are spheroidal, and destitute of chlorophyll. Here and there spiral vessels traverse the medulla, quite isolated from the general vascular circle. In the more fully-developed excrescences the appearances are similar, except that the outer epidermal cells now show themselves in the form of long cylindrical cells (hairs), some of which are club-shaped at the extremity. Some of these hairs appear to be uni-cellular, while others show one or two transverse partitions. The hairs in question are rather thick-walled, and contain a few scattered small highly refracting granules (starch ?) resembling the granules found in autumn when the leaves have assumed their autumnal tints in consequence of the decay of the chlorophyll. From these appearances the inference seemed to be that the growths in question were of the nature of adventitious roots covered by hypertrophied epidermal hairs."

Icicles in Plant Cells.—In the 'Comptes Rendus' for February 21st there is a paper by M. Prillieux on this subject. He has established the existence normally of large icicles in the interior of all frozen plants. These icicles form small columns, perpendicular to the surface, and often penetrating the epidermis. The ice is formed from liquids derived from the cells. The cells themselves remain intact, so that there is no destruction, but simply a separation of organs, and therefore what has been said concerning the death of plants by freezing goes for nothing.

The Structure of Steel as seen by the Microscope.—In a note published in 'Scientific Opinion' of March 2nd, a record of some of M. Schott's (of Ilsenberg) recent researches in the crystals of iron and steel is given. M. Schott maintains that all crystals of iron are of the form of a double pyramid, the axis of which is variable, as compared with the base. The crystals of the coarser kinds, as compared with those of the finest qualities of crystalline iron, are of about twice the height. The more uniform the grain, the smaller the crystals, and the flatter the pyramids which form each single element, the better is the quality, the greater is the cohesive force, and the finer the surface of the iron. These pyramids become flatter as the proportion of carbon contained in the steel decreases. Consequently in cast iron and in the crudest kinds of hard steel the crystals approach more the cubical form, from which the octahedron proper is derived, and the opposite extreme or wrought iron has its pyramids flattened down to parallel surfaces or leaves, which in their arrangement produce what is called the fibre of the iron. The highest quality of steel has all its crystals in parallel positions, each crystal filling the interstices formed by the angular sides of its neighbours. The crystals stand with their axes in the direction of the pressure or percussive force exerted upon them in working.

The Structure of Eozoon.—Professors Rowney and King, of Queen's College, Galway, still dispute the view propounded by Dr. Carpenter, and now generally accepted among biologists, that the Eozoon structure is the fossil relic of some protozoan animal. At a meeting of the Royal Irish Academy held last month, the Secretary read a note by Professors King and Rowney, of Galway, supplementary to a former paper on "*Eozoon Canadense.*" "The note," say the authors, "is descriptive of two specimens, one from Aker, Sweden, and the other from Amity, New York. The Aker specimen is a crypto-crystalline mass of calcite, enclosing numerous lobulated grains of coccolite, respectively identified with the 'supplementary skeleton' and 'chamber casts' of this reputed organism in its 'acervuline' form. Their presumed organic origin, however, is clearly a fallacy, as the grains of coccolite display unmistakable evidences of having been originally crystals that have had their edges, solid angles, and faces, more or less rounded off by some dissolving agent. Imbedded in the calcite are numerous long crystals of what appears to be malacolite, lying about singly and in aggregations. In most instances the crystals have lost some or all of their planes, angles, and edges, so that many present themselves under the massive contorted cylindrical forms peculiar to the so-called 'stolons;' others, through prismatic cleavage, are broken up into slender prisms, which, in numerous instances, are reduced by erosion; and further division, to simple and branching configurations, assuming all postures and modes of groupings. The latter match in beauty the finest examples of the 'canal system' seen in typical 'eozoonal rocks' occurring in Canada. The Amity specimen consists of a similar calcareous matrix, holding crystals of spinel, malacolite, and other minerals. In one of the crystals of spinel, an octahedron, about 2½ in. in its axial diameter, the planes exhibit numerous irregular cavities and linear chinks filled up with crypto-crystalline calcite; in the latter substance, *thus situated*, there are numerous beautiful examples both of 'stolons' and 'canal system,'—all clearly originating from crystals of malacolite."

NOTES AND MEMORANDA.

American Microscopes.—The recent Report of the Judges (Mr. Wightman, Dr. Curtis, and Mr. Stevens) on the Philosophical Apparatus exhibited at the Exhibition of the Massachusetts Mechanic Association, held at Boston, in September, is highly favourable to Messrs. Tolles. Of the specimens exhibited by the makers the Report says:—

"The microscopes exhibited comprise a variety of instruments and accessories, embracing much that is original and ingenious, and characterized by nice workmanship and elegance in appearance.

"One large microscope with A and B Huyghens' eye-pieces, and Tolles' patent solid C eye-piece, with micrometer, has a very ingeniously constructed rotary stage, devised by Mr. Tolles, which is only one-sixteenth of an inch thick. Its rotary movement is concentric with the axis of the objective. It has also lateral movements by friction rollers, and a sub-stage, movable by rack and pinion, for accessory apparatus.

"There are several other instruments intended for students, which are much less elaborate. These are supplied with a one-inch and a one-fourth inch objectives, both of second quality, and have coarse and fine adjustments, and also the means for applying accessories. We should also here mention a pocket achromatic triplet.

"In the list exhibited, we find a binocular eye-piece, and a solid eye-piece, both invented by Mr. Tolles; and although the latter was patented in this country by him several years ago, we were shown a similar device, in fact nearly identical in every essential particular, by a scientific friend, who has just returned from a sojourn in Europe, where he purchased it as a new and valuable *oculaire*, one of the latest improvements just invented by a microscope maker of celebrity in Paris.

"Among the instruments on exhibition, we find first-class objectives, as follows: a one-inch, having an angle of aperture of 27°; a half-inch, with 60° angle of aperture; a one-fourth, with 70° angle of aperture, and constructed with a Tolles' illuminator for opaque objects; a one-sixth immersion, with 150° angle of aperture; and a one-tenth immersion, having an angular aperture of 175°.

"It is mainly to improved object-pieces or objectives, as they are more frequently termed, that the world is indebted for the means of extending the limits of our knowledge through the revelations of this valuable instrument. Since the middle of the present century, improvements have been made, and a degree of perfection approximated in the construction of microscopic objectives, which twenty years ago were pronounced by the best authorities as utterly unattainable.

"Messrs. Powell and Lealand, Smith and Beck, and Ross, and others of England; and Nachet, and Hartnack, and others of France, besides many very reputable makers in Continental Europe, have honourably vied with each other in advancing improvements upon the higher order of objectives. But while such eminent practical skill has endeavoured to meet the wants of scientific men abroad, in pushing their research beyond that of their predecessors, there has been no less demand by restive intellects in this country for the very best instruments, and no less intelligence and skill in successful efforts to meet such demand. Among those practical photonomers who have been the most successful, whether at home or abroad, in the scientific construction of the highest order of optical instruments, the samples on exhibition from the Boston Optical Works well warrant the assertion that their superintendent has advanced to the foremost rank.

"In microscopic objectives, it is obvious that the extent of amplification, and the character of the light as well as the kind and degree of illumination, are more or less common to all makers. Other things being equal, the relative as well as the absolute merits of objectives are commensurate with their degree of distinctness of delineation or definition. This quality must not merely cover the outline of infinitesimal objects, so to speak, but extend to the minute details of their structure and colouring. The higher powers of course more largely magnify any and all defects or imperfections due to their own imperfect construction; hence the true merits of objectives are in favour of those of the lower powers, which under like circumstances give equal distinctness in definition or resolution.

"The obstacles to perfection in this direction were various, numerous, and enormous, so much so that those savans familiar with them were generally the most decided in pronouncing them all but insurmountable. But for the high degree of perfection in our present make of instruments, as well as our hopes for still better ones, we are largely indebted to practical opticians, whose perseverance in their study of the laws of light and the principles which prevail affecting the same; in the material of which the lenses are made, as well as mathematical precision in giving them form, relationship, and combination, was coupled with long series of laborious, but patient trials, studded with discouraging failures, while on their tedious way to eventual success.

"The judges took as much pains as circumstances permitted to compare the workings of the instruments on exhibition with others of the most reputable makers in this country and Europe. The objective of the highest power was the one-tenth immersion, whose angle of aperture is 175°. Under the observation of the judges, and others whose assistance was invited, this objective defined test-objects better than any objective of the same power, and as well as many others of higher powers, from other makers, which were at their command. The usual tests were resorted to, such as the *Pleurosigma angulatum*, *Surirella gemma*, &c., &c., among the Diatomaceæ, and Nobert's test-plate from artificial sources. The latter is *par excellence* the test of the quality of objectives. It consists of straight lines uniformly ruled on glass, and is not subject to the variations which prevail in different individual specimens of the same species, among natural objects. The test-plate used was one of Nobert's later make, containing nineteen bands, the last of which, or the nineteenth band, was composed of lines so fine and close that it requires over 112,000 to occupy the space of one inch. These were clearly resolved by direct* light illumination from a kerosene lamp, with the one-tenth immersion objective† and a B eye-piece. Among those invited who witnessed this performance may be named Professor Wolcott Gibbs and Dr. B. A. Gould of Cambridge. The true lines of this nineteenth band have never yet been seen by Nobert himself, and their resolution has been pronounced both by him and many European microscopists of eminence as physically impossible. We cannot learn that anyone in Europe claims to have seen them, if we except, perhaps, Nachet of Paris. At the U. S. Army Medical Museum in Washington, D.C., with a one-sixteenth immersion objective, made by Powell and Lealand of London, the sunlight being controlled by a heliostat and rendered monochromatic, excluding all rays of the spectrum except those of the shorter wave-length, and condensed with a one-sixth objective of Tolles' make, the lines in question have been photographed.

"The one-inch objective on exhibition is constructed for use in water, and seems admirably adapted for tank work where minute dissections are to be performed. The prism arrangement of the one-fourth objective for illuminating opaque objects through its anterior combination lens is new and worthy of special consideration. It is simple, its use employed or readily cut off, and is free from the glare and other objections which have rendered nearly useless all former efforts to improve the illumination of opaque objects under high powers.

"The binocular eye-piece is also the invention of Mr. Tolles. It not only seems to do well what any other form of binocular microscope will do, but it is also suitable for use in those cases where all other binoculars fail, their uses being limited to the lower powers in consequence of the relationship of their binocular arrangement to the objective. Mr. Tolles' arrangement connects it with and makes it a part of the eye-piece. It may also be used with telescopes."

Belgian Prizes open to Microscopists.—Among the prizes offered by the Belgian Academy of Sciences in 1871 are the following:—(1) A determination, by new researches, of the position which the genera Lycopodium, Selaginella, Psilotum, Tmesipteris, and Phylloglossum ought to occupy in the natural series of vegetable families; (2) a description of the mode of Reproduction in Eels. The prizes will be gold medals, each of the value of 32*l.* (800 francs). The essays are to be written legibly in either Latin, French, or Flemish. The authors of the essays inserted in the reports of the Academy will have the right to 100 copies of their essay free, and as many additional copies as they wish at the rate of four centimes per sheet. The

* Direct light should not be confounded with central light. The light was direct from the lamp, unmodified; of course it was very oblique.

† This is the same instrument referred to by Dr. J. J. Woodward in his paper in 'The American Journal of Science' for September, 1869, and in a communication to the 'Monthly Microscopical Journal,' London, for December, 1869, and called by him an eighth only.

editions and pages of the works quoted must be given. The essays must not bear the name of the author, but a motto, to be repeated on a sealed envelope containing the name and address. The essays become the property of the Academy, but permission will be given to take copies. They are to be sent, post-paid, to M. Ad. Quetelet, Perpetual Secretary, before June 1st, 1871.

The Histology of the Petiole in Cryptogamia forms the subject of a recent lecture by M. Trécul to the French Academy of Sciences.

The Development of the Flower in Pinguicula.—A very able memoir on this subject has been written by Professor Dickson. This was very favourably noticed by the Rev. M. J. Berkeley, F.R.S., in a late number of 'The Gardener's Chronicle.'

A New Edition of Mrs. Somerville's Work on Molecular and Microscopic Sciences. — In a note written from Naples, Professor Allman states that a short time since he paid a visit to Mrs. Somerville. Writing to the Botanical Society of Edinburgh, he says:—"I paid a visit the other day to Mrs. Somerville, on her ninetieth birthday. She is a charming old lady; her senses, with the exception of slight failure in her hearing, are still perfect; she can thread her needle without spectacles, and is in full intellectual vigour. She is engaged with a second edition of her work 'On Molecular Science.'

The American Microscopical Society.—At the last annual meeting of the American Microscopical Society the following officers were elected:—President, Dr. J. H. Hinton; 1st vice-president, Mr. Robert Dinwiddie; 2nd vice-president, Mr. T. F. Harrison; corresponding secretary, Dr. S. G. Perry; recording secretary, Dr. J. S. Latimer; treasurer, Mr. E. C. Bogert; librarian, Dr. John Frey; curator, Mr. S. Jackson. Committee on nominations:—Dr. D. H. Goodwillie; Mr. R. A. Witthaus, Mr. J. W. S. Arnold.

M. Mouchet's Wood-section-making Machine.—M. Mouchet desires us to state that the "grande médaille d'honneur," awarded to him by His Majesty the Emperor of the French, was received at the "Regional Exhibition of 1866," and not, as stated in our February number, the late Paris Exhibition.

An Histological Entomological Prize.—The Council of the Entomological Society offer two prizes, of the value of five guineas each, for essays of sufficient merit, drawn up from personal observation, on the anatomy or economy of any insect or insects. The essays to be sent in before the end of November next.

The Microscope in Silk-Worm Culture. — M. Pasteur, who has done so much in this direction, proposes this year to carry out an elaborate series of experiments on the subject of silk-worm growth, health, and nourishment. These experiments will be carried out on an estate of the Prince Imperial, situate between the Gulf of Trieste and Carnero.

The Development of the Brachiopoda.—A very capital subject for some enterprising microscopist is being investigated by Mr. E. Morse, who is engaged in writing a monograph on the subject.

The Transmission of the Journal Abroad.—The communications of Professors Vanlair, Van Beneden, and Masius have reached us, and have been laid before the publisher, who has complied with the orders expressed therein.

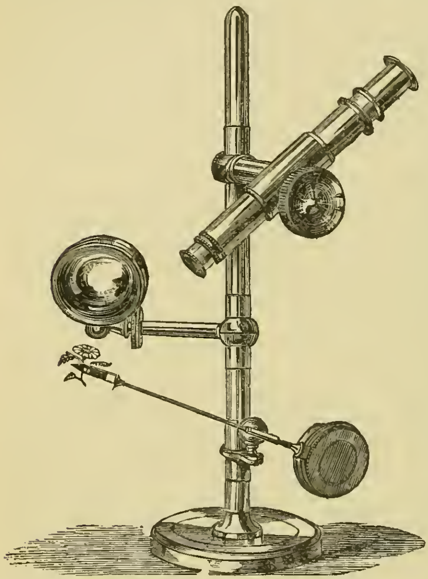
The Microscope in the Welsh Fasting Girl's Case. — A curious instance of the practical value of the microscope in many inquiries in which its use would not be suspected by those not versed in its employment, was shown in the recent prosecution. Mr. John Phillips, surgeon, in giving his evidence, mentioned that he also examined with a microscope the contents of the stomach. He recognized starch globules in abundance, and several small pieces of bone—either of small fish or small birds. The starch was most probably taken from arrowroot.

A New (?) Binocular Microscope.—A recent number of the 'British and Foreign Mechanic' contains a description, with figures, of what is called an improvement in binocular microscopes, by Mr. Samuel Holmes. The following is part of the inventor's specification, for we may mention that the instrument is patented :—

"My invention consists in the use of two object-glasses or portions of two object-glasses, or of one object-glass divided into two parts, to supply through two eye-pieces a binocular and stereoscopic view of opaque or transparent microscopic objects while illuminated by reflected or transmitted light, and also in the use of certain mechanical means herein described, or their equivalents, for securing the motion in required directions, or rest in necessary positions of the optical parts of such combinations for obtaining monocular or binocular vision. The objective—I take an ordinary object-piece, and by a circular saw divide it along its line of collimation, and afterwards rejoin the halves by screws and steady pins, until as an objective it is in as perfect a state of adjustment as before division? It is then capable of acting as an objective for one or two eyes, according to the position assumed by the two halves under the control of the mechanical part of the instrument when the direct light is stopped out. According to another method, I work the lenses of an achromatic object-piece out of divided and rejoined discs of glass, which when finished and fixed in a divided mounting temporarily held together for that purpose may be afterwards separated by dissolving out the cement by which the halves of the discs were originally conjoined. Or lastly, I make two whole object-glasses, and fix one into each half of a divided mount, cutting away only such portion as will allow of proper approximation. This method is available for high powers and for binocular use only. In all cases I cut the usual screw-thread on the objectives to affix them to the body, and more surely secure their halves in their respective places in the divided body tube of the instrument by two small milled-headed screws."

A Revolving Stage and a Tank Microscope. — Mr. Frederick Blankley read the following note at the last meeting of the Royal Microscopical Society :—"I have much pleasure, at the request of our esteemed President, in bringing before this Society two small contrivances which I hope will assist us in our pleasant microscopic studies. The universal revolving stage consists of two plates of brass, in the centre of which is a revolving disk, so constructed that different appliances may be placed in it.

" The one before you has a live-box, which can be placed in the centre, and by turning the milled edge will rotate, so that the object viewed may be seen at every angle of light; also a cork disk upon which may be fixed any object wished to be seen in various positions; and an object-holder which does equally well for transparent or opaque-mounted objects. This piece of apparatus is the result of the desire to see objects in different positions and under every aspect. It is made by Mr. J. Swift, 128, City Road.


Mr. Blankley's Tank Microscope.

" The Tank Microscope is constructed in a simple and inexpensive way, which may induce many to study 'Life as it is' in the aquarium, without having to expend a large sum of money for the purpose. It will be observed that the ordinary condenser is used as the stand or pillar for the microscope, which consists of a sliding arm, into which the body of the instrument is placed; and by having a revolving joint it can be moved in every direction. On the pillar will be seen a small sliding, fitting into which can be placed the stage forceps, leaf-holder, cork disk, &c., so that it will be not only serviceable for tank work, but also for geological and botanical purposes; and by placing it in a vertical position, and using a mounting table of block of wood, can be converted into a dissecting microscope: this also is made by Mr. Swift."

A Diatom Committee.—Captain Lang, the President of the Reading Microscopical Society, sends us a note, in which he makes the suggestion that the Royal Microscopical Society should appoint a Committee of Reference for those who are engaged in diatom inquiries. "In last month's number of 'Science Gossip,' in an entire article by L. G. Miles "On Guano Diatoms," there is a proposal worth consideration. After giving examples of abnormal forms, and remarking on the tendency towards extensive multiplication of supposed new species on insufficient grounds, this writer suggests that as the Royal Microscopical Society, as a national institution, is now looked up to as a guide to British microscopists generally, it would be well that a Committee of veteran Diatomists of that Society should be formed, to whom all new or doubtful forms might be sent for examination or identification. The recommendation appears to me to be a good one, and such a committee might easily guard themselves from the trouble of naming common valves for tyros, by making a rule only to receive specimens forwarded to them through some member of the Royal Microscopical Society."

PROCEEDINGS OF SOCIETIES.*

Royal Microscopical Society.

King's College, *March*, 1870.

Rev. J. B. Reade, M.A., F.R.S., in the chair.

The minutes of last meeting were read and confirmed.

A donation from the Royal Society was announced by the Secretary, consisting of certain parts of the 'Philosophical Transactions,' which would render complete the volumes of that work presented to the Royal Microscopical Society by the President, and to which reference was made in the current number of the Journal.

Mr. Slack moved, and it was unanimously carried, "That the thanks of the Society be given to the Royal Society for the parts of the 'Transactions' which had been so generously presented."

The President said, the presentation of those parts now made the volumes in the possession of the Society complete from 1751 to the present time. They were therefore greatly indebted to the Royal Society for their contribution. He would just mention that the Council had come to the conclusion to have the parts bound into volumes; and that the volumes might be borrowed for the space of one month, on condition that the Fellows submitted to a fine of 1*s.* per day for default in returning them. It was necessary that regularity should be observed on this head, and probably the penalty of incurring the fine would ensure such regularity. He thought that such volumes could only be studied satisfactorily by the Fellows at their own homes, and that with this privilege of taking the volumes from the library before them, many gentlemen would be glad to join the Society for the sake of having free access to such a work.

Mr. Ladd, F.R.A.S., of Beak Street, Regent Street, exhibited that evening a simple form of spectroscope and micro-spectroscope combined. The maker described it as a form of spectroscope contrived by him in 1868. Its size, when closed, is 2 inches long and $\frac{7}{10}$ inch diameter. It can be applied to the microscope very effectively in the following way:—The tube containing the direct-vision prisms is

* Secretaries of Societies will greatly oblige us by writing their reports legibly —especially by printing the technical terms thus: H y d r a—and by "underlining" words, such as specific names, which must be printed in italics. They will thus secure accuracy and enhance the value of their proceedngs.—Ed. M. M. J.

mounted above the ordinary eye-piece of the microscope by means of a tube adapted (taking the place of the eye-piece cap), in which the prism tube will slide. An adjustable slit is made to take the place of the micrometer in the eye-piece. When a second or comparative spectrum is required, it is only necessary to place below the object-glass either a "Reade's" or a right-angled prism, or a simple reflector, and the two spectra will appear side by side. By this arrangement all the advantages of the more expensive forms of instruments are obtained at a small cost. It was as well a spectroscope for non-microscopic work.

A new form of rotating stage of portable character was exhibited by Mr. Blankley, and also a very convenient pocket travelling microscope by Mr. Browning. This very portable form of instrument was made for a gentleman connected with the Excise, who, being much engaged in the examination of suspected articles, is obliged to carry a microscope about with him in his daily duty.

Mr. Moginie also exhibited his monocular and binocular travelling microscopes; and Mr. Richards his arrangement for working more accurately with Darker's selenite films.

Dr. Carpenter compared "The Steadiness of the Ross and Lister Models of Microscopes under trying circumstances." He also entered into some interesting details "On the Shell-Structure of Fusulina," "The Micropyle of the Fish's Ovum," and "The Reparation of the Spines of Echini."

Mr. Beck thought the real credit of carrying out the principle so ably commented upon by Dr. Carpenter belonged to Mr. Jackson. He did not think that in Mr. Lister's improvements would be found the full development of the principle. He had in his possession the first microscope that had been made on Mr. Lister's model, as brought out by Tulley; and whilst the principle is firmly maintained of moving the body, there is no approach to the beautiful movement for which they were indebted to the mechanical skill, and thorough knowledge and distribution of vibration, of Mr. Jackson. George Jackson was the man who introduced the planing out that arm; and he thought that he was correct in saying that it was planed out by Mr. Jackson in an amateur planing machine of his own.

The President said Tulley's microscope was the Lister model. The supporting rods gave great firmness, but the form exhibited by Dr. Carpenter was unquestionably the Jackson form. Still the question is, which form is the most valuable for diminishing the tremor?

Mr. Breese said, it seemed to him that the question of vibration must be mainly dependent upon the steadiness of the object-glass and object taken relatively, and consequently on the rigidity between these parts, and had but little to do with the eye-piece, as spoken of by Dr. Carpenter. He would contend that the Ross model is the steadier of the two. The point of support for the object-glass is much nearer the object, and there is no danger of motion in the tube interfering at all. Without calling in question the experiments made by Dr. Carpenter, he thought that a Ross model, which he had had in his own hands, bore as severe a test, and exhibited no defect such as has been spoken of. He had to carry on some experiments at a railway station, where everything was in a state of vibration (so much so that when heavy trains passed small scalpels chattered on an earthen plate); and he found that the Ross model with a $\frac{1}{8}$ objective worked admirably. He did not assert that the Ross model was the best in all respects; but at the same time he could not see any logical inference that the tremor was due to motion in the eye-piece; and while the point of support was near the object-glass, this has but little motion.

Dr. Carpenter.—Let any gentleman take the eye-piece between his fingers and give it a touch, he will at once convince himself that the tremor is from the eye-piece. You may touch the other portions of the instrument and produce no tremor.

Mr. Lobb said, without reference to any particular make of microscope, he would suggest that, having had considerable experience in the use of high powers, unless the slow motion be excessively steady, there must be a great vibration of the object under inspection. To view the objects satisfactorily, not only must the instrument be steady, but the slow motion also.

Mr. Ladd thought that it was scarcely fair to take two single microscopes and compare them in the manner alluded to. He could understand that if a microscope were taken which was a little worn, the screw that tightens the bar and would make it steady might be in fault. It was quite possible, in selecting a microscope at random, to account for all the shaking spoken of by Dr. Carpenter, since all depends upon the way in which the instrument is screwed up. There is the round bar at the bottom, and a little shake at that part would account for all Dr. Carpenter had referred to.

Dr. Carpenter explained that the instrument used by him was not worn at all; it was one recommended in the Canadian survey.

The President proposed a vote of thanks to Dr. Carpenter for his papers.

Dr. Carpenter said he ought to apologize for the mistake he had made in his book. He had overlooked the fact that the particular plan was Mr. Jackson's; but he thought the title of his paper should remain, and he would add an explanatory note.

Mr. Slack said that he was sure the Society was much obliged to Dr. Carpenter for the interesting subjects he had brought before them, and that general regret would be felt that there was not sufficient time to discuss them properly.

The President then announced that the soirée would be held on the 20th April next, when he hoped a larger number of Fellows would bring their microscopes than had done so on two or three previous occasions.

Mr. Beck inquired whether the soirée was to be of the same character as formerly. Without wishing to say anything against the plans which had already obtained, he should very much like to see a new mode of conducting this annual entertainment. It was highly desirable, he thought, that there should be one day in the year on which the Fellows could meet for some useful purpose, and when they can see the scientific exhibition of microscopes and microscopic objects.

Mr. Lee said he desired to see the soirée carried out in a better manner. He considered it a downright disgrace to the Society that only four Fellows had replied to the inquiry respecting the objects they intended to exhibit; and that only about a dozen besides the Council had exhibited their microscopes on the last occasion. It was merely a trade soirée. He said this without any disrespect to the opticians who had supplied the chief attractions of the evening. He was not prepared to advocate the abandonment of the soirée, but he did think that the exhibition of objects and microscopes should be more in accordance with the Society's character.

Mr. Slack said that, in accordance with desires expressed to that effect, the Council had endeavoured to give the soirée on the last occasion a more scientific character. It was extremely difficult to unite the requirements of a scientific gathering with those of a crowded evening party. If the latter character were abandoned, he hoped a good substitute would be found, so that we might not lose the advantage of a friendly gathering cf Fellows with their wives and daughters.

Mr. Beck said, what he wished to have was a separate evening devoted to purely scientific purposes. They need not give up the public meeting on this account.

Mr. Lee said if it was proposed to have two soirées, one of them purely scientific, he should vote for the proposition.

Mr. Slack said he would not do away with the soirée, but he would propose that an evening should be devoted to the completest possible exhibition of the recent discoveries, new instruments, objectives, best methods of showing difficult or disputed objects, &c., &c. This would be a strictly scientific meeting, and the numbers could be limited to about half those who usually attended, that the objects might be seen. An excursion might then be organized for another day, to which ladies could be invited to join, and when methods of collecting and examining objects could be shown.

Dr. Carpenter fully coincided with the remarks that had been made on the non-scientific character of the soirée, and the difficulties of making it a scientific meeting were most apparent. But he would just say that whatever plan might be adopted, he was willing to aid the Council most cordially. He would engage to exhibit as many objects as they could provide microscopes for, and would also be happy to lend them large drawings which he had in his possession, which would indicate the nature of the objects displayed.

The President said, he gathered from the remarks which had been made, that it was the wish of the Fellows that there should be a purely scientific evening, on which they could meet together, and also a more social evening, conducted as formerly. The scientific meeting would have this advantage, *viz.* that it would be exceedingly inexpensive.

The President then put it to the meeting which of the two plans should be carried out—the social excursion suggested by Mr. Slack, or the evening party. The latter was adopted by a large majority.

After a few more remarks from Mr. Beck, the President announced that the meeting was adjourned to the 13th April next.

Donations to the Library from February 9th to March 9th, 1870 :—

	From
Land and Water. Weekly	*Editor.*
Society of Arts Journal. Weekly	*Society.*
Nature. Weekly	*Editor.*
Quarterly Journal of the Geological Society. No. 101	*Society.*
Scientific Opinion. Part XVI.	*Editor.*
Quekett on the Microscope, *2nd Edition*	*Dr. Millar.*
Ditto ditto *3rd Edition*	*Ditto.*
Philosophical Transactions for the Years 1813, 1836, 1837, 1838, and 1843	*Royal Society.*
Description of the Improved Achromatic Microscope. By W. and T. Tulley. 1832	*President.*
Report of the Committee of the R. A. S. on W. Tulley's first large Achromatic Telescope, 1828, with an Object-glass 6–8 inches clear aperture	*President.*
Report from the U. S. Army Medical Department, on the Magnesian and Electric Light for the Purposes of Micro-photography	*Surgeon-Gen. U. S.*

Peter Le Neve Foster, Esq., M.A., was elected a Fellow of the Society.

WALTER W. REEVES,
Assist. Secretary.

QUEKETT MICROSCOPICAL CLUB.*

At the ordinary meeting of the Club, held at University College, February 25th, 1870, P. Le Neve Foster, Esq., M.A., President, in the chair, four new members were elected, four gentlemen were proposed for membership, and several presents to the library and cabinet were announced. Mr. M. C. Cooke read the translation of a paper by Monsieur Alphonse de Brebisson, corresponding member of the Club, entitled "Critical Notes upon British and Normandy Diatoms." The paper was of a technical and critical character, and of much value as bearing upon the question of "new species" of classification; upwards of twenty slides in illustration of portions of the paper were presented to the cabinet of the Club.

Mr. B. T. Lowne made some interesting observations upon the structure of the cornea of the bee, founded upon some recent dissections of the eyes of a large African species of carpenter bee. The Secretary read a short paper descriptive of a number of varieties of *Triceratium*, found upon a slide prepared from Jutland cement stone, a diagram of the diatoms being exhibited. Some critical remarks upon the paper having been offered by Mr. M. C. Cooke, the Secretary announced that Mr. Lowne was about to commence a class for members of the Club who were desirous of studying microscopic zoology, and the proceedings terminated by a conversazione, at which objects of interest were exhibited by Messrs. Brown, Golding, Hainworth, Hislop, and White.

The annual soirée of the Club was held on March 11th, at University College, which was kindly lent for the occasion by the Council. A large number of microscopes were exhibited in the library and

* Report supplied by Mr. R. T. Lewis.

museum by the members. Interesting collections of photographs were lent by the India Office, the Autotype Company, Messrs. A. E. Durham, F. Good, and A. L. Henderson, and Flaxman's studies were open to the inspection of the visitors in the Shield room, whilst in dark rooms, at frequent intervals, exhibitions of micro-photographs were admirably shown by Mr. How. Mr. Solomon showed his process of photography by the magnesium lamp, and Mr. Apps performed a variety of brilliant experiments with induction coils and vacuum tubes. Refreshments were served in the museum and in one of the class-rooms. A numerous and brilliant company attended during the evening, who were received on entrance by the President, Secretary, and members of the Committee.

Literary and Philosophical Society of Manchester.

(*Continuation of paper* " *On the Natural Ropes used in packing Cotton Bales in the Brazils,*" *from page* 172.)

Bignoniaceæ.—Travellers in the Brazils tell us that by far the larger number of climbing plants in the South American tropics belong to the natural order Malpighiaceæ, and we should therefore expect that this would be the family which furnishes the majority of natural ropes. But this does not appear to be the case; the Bignoniaceæ stands pre-eminent as the natural order most largely used for supplying lianas for packing purposes, both as regards the quantity of ropes, and the largest number of species.

Most of them are readily identified by the remarkable and symmetrical outlines presented by the cortical and woody systems of their stems when seen in a horizontal section, the bark being projected into the woody tissue, towards the centre, in the form of rays. These cortical rays are wholly formed of liberian fibres, and they vary in colour according to the species. In the majority of stems such prolongations of the bark are four in number, disposed after the manner of a Maltese cross. In a few species each of the four cortical portions is very thick and perfectly square in contour, but in the larger number they are long and slender, frequently reaching the pith itself.

The yearly additions to these rays do not proceed after a uniform method, and I shall notice two or three of the principal arrangements. The more common is that where the four primitive rays are deeply projected into the woody portion, the additions taking place each season in the form of plates deposited on each side of the primitive cortical ray. It is difficult without the aid of a diagram to convey a clear idea of the sequence in which the various portions of bark and wood are formed; suffice it to say that each successive addition of bark is projected into the wood a shorter distance than its predecessor, and as the innermost extremity of every plate is truncate or rectangular, it follows that the outline presented by each cortical mass is that of a pyramid, whose sides are formed of a series of rectangular steps like an ordinary stone staircase. It is difficult to account for this singular appearance, but the more probable explanation seems to be that a layer of wood is deposited for every layer of bark, so that by the time a new deposition of the bark is about to take place the wood has already surrounded the extremity of the previous plate, in consequence of which the progress of the new plate inward is barred by the previous season's layer of wood. If this explanation be sound the number of cortical plates on one side of, and including the primitive cortical ray, indicates the age of the stem under examination. Each annual layer of wood is thus broken up into four distinct portions by the projecting bark, each portion filling up one of the spaces enclosed by two of the arms of the cross. The number of plates formed on each side of the four primitive cortical rays rarely exceeds six. The peculiarity of arrangement, to which I here draw attention, is so striking, that it is a matter of surprise to see this feature so badly represented in Gaudichaud's plates; it is fairly drawn by Schleiden, in his 'Principles of Botany,'* but a better figure is given by Duchartre, in his 'Eléments de Botanique,' p. 167.

Another arrangement of the cortical portion is also common. It commences, as in the last method, with the projection of four slender rays into the midst of the woody fibres, reaching about half-way to the pith; but the next additions which take place are not found by the side of the four primitive rays, as in the first-noticed arrangement, but occur as four new projections placed exactly midway between the first four, so that the stem now exhibits eight of these rays arranged like the spokes of a cart-wheel. At first, the four secondary rays are very much shorter in length than the four primitive rays, but as the stem increases in age all the eight rays become of equal length. Even in this type some species exhibit an approach to the first type, by some of the primitive rays in the older stems having one or two lateral plates lying alongside them.

Perhaps the most striking form of all the Bignoniaceæ which I have hitherto examined is one which unites the peculiarities of both the preceding arrangements, but carried to such an excess as that the cortical portion at last forms one-half the bulk of the stem. Originally, the woody portion is arranged in the form of a cross, the bark filling up the whole space enclosed by the four arms of the cross. According as the stem increases in diameter, new cortical rays are projected into the four extremities of the woody mass, so that the arms appear to be bifid; these bifurcations also in their turn become bifid, and so the woody mass has its primary, secondary, tertiary, and quaternary divisions according to its age. Further, as the innermost cortical deposit—that surrounding the woody tissue—is very dark in colour, it throws into high relief the stellate outline of the woody portion. I have met with only one or two species of Bignonia which furnish this elaborate arrangement, and the specimens exhibited will show its striking character.

The woody system of the stems belonging to this natural order is by no means uniform, but it requires careful study before a detailed description can be given. Nearly all the species, however, have

* Pp. 251, 252, of the English translation.

numerous vessels of large diameter imbedded in the woody tissue, so that the stems are for the most part very light and porous. Such an arrangement might have been expected in plants whose stems are only as thick as a finger, and whose sap has to travel a long distance before it can reach the leaves, which are for the most part met with only in the uppermost portions of the stems. In most of the species, this woody tissue is traversed by a large number of fine medullary rays, which give a beautiful figure to many of the sections. Their internal arrangement does not manifest itself in any marked way on their exterior; their form is generally cylindrical, but some of them exhibit four slight projections in the form of narrow raised bands arranged lengthwise, which correspond with the outermost portions of the four cortical rays. Some species have a square stem during their early growth, and even the older stems do not altogether lose their four-sided character.

The constancy of the figure four as the radical number is very noticeable in the structure of the different parts of these stems, and there can be little doubt that it originates in the decussate arrangement of the leaves. The stems of the Mints, Sages, and many other British plants furnish us with ready examples of a quadruple arrangement of parts.

Malpighiaceæ.—If the lianas which belong to the Bignoniaceæ are remarkable for the symmetry of their parts, the lianas of this family may be said to be characterized by an absence of symmetry. In general, their stems are singularly rugged in outline, a section presenting deep sinuosities or irregular projections, while at other times they appear to be made up of a number of separate branches which have become consolidated in the progress of growth, so as to form a rough-looking rope of many strands.

Jussieu gives a full and interesting account of the structure of one of these stems, the *Stigmaphyllon emarginatum*,* and Gaudichaud† figures an allied species; but I have not, as yet, identified either amongst those coming with cotton. I exhibit, however, a stem which appears to be the *Tetrapterys Guilleminiana* referred to by Jussieu, and figured by him in his Monograph; ‡ but this species does not exhibit the sinuosities so characteristic of most of the lianas of this family.

As a general rule, the woody matter is developed unequally round the central pith in the form of irregular lobes, the bark closely following all the sinuosities of the stem. If the lobes increase on one side of the stem only, the pith soon becomes eccentric; but, on the other hand, in many species, while the pith retains its central position, the irregular growth of the woody lobes—each of which is closely invested by the bark—causes some to grow beyond their neighbours, and these latter, in the progress of growth, become imbedded, with their bark, in the midst of the woody matter produced by the more vigorous lobes. A stem in this adult state therefore presents the greatest irregularity of form, particularly in the genera *Banisteria* and *Heteropterys*.

Sapindaceæ.—In this natural order we meet with some wonderful

* Mémoire,' &c., pp. 103, &c.
† 'Recherches,' &c., pl. xviii., fig. 11, p. 129.
‡ Plate iii., fig. 5, p. 106.

aberrant forms of dicotyledonous stems, but I shall here notice only two which are met with on cotton bales.

One of these is most probably the *Serjania cuspidata* figured by Duchartre* and Schleiden,† and easily recognized by its triangular form and compound character. It consists of a primitive stem not specially noticeable for any divergence from the usual type of a dicotyledonous stem; but round this stem are arranged three other lateral stems, each of which has its own bark separate from the rest, but united to the bark of the primitive central stem. These lateral portions are circular in outline, save that they are flat on the side by which they are attached to the central stem, which latter is in consequence hexagonal. The attachment of the lateral portions to the central mass is not very firm, as most of the ropes of this species reach this country with their strands separated, but this is due to the rough usage to which they have been subject in packing; but Gaudichaud points out that in certain parts of the stem—most likely at the nodes, for he is not very clear upon the point—the lateral strands have an organic attachment to each other, since some of the woody fibres of the central mass are continued in one of the lateral strands, and *vice versâ*.‡

A still more remarkable example supplied by this family in the form of a natural rope, is one which might have served our telegraph engineers as the model of a submarine cable. Like the Serjania, there is a central woody mass possessing a medullary sheath and pith, woody layers, and a cortical system; but surrounding this central core and arranged parallel with it is a series of eight lateral strands, each surrounded by its own bark, the whole being consolidated so as to form a rigid cylindrical axis, which presents no external manifestation of its peculiar internal organization. It is represented in the last figure of Gaudichaud's 'Recherches,' § and has been copied into most of our text-books, in some cases incorrectly described as a Malpighiaceous plant, as by Professor Balfour in his 'Class Book,' figs. 186 and 1429.

On examining such stems of this order as I have been able, the pith and medullary sheath with its characteristic tracheal vessels appear to be met with in the central mass only, and some botanists, contrary to the opinion expressed by Jussieu,‖ doubt the existence of these organs in the lateral strands. Nevertheless, one of the most recent observers of these stems, Herr Nägeli, has recently demonstrated their presence in each of the surrounding woody masses.¶

A short summary of their mode of growth, communicated to the French Academy by Monsieur Netto, will be found in 'Comptes Rendus,' t. lvii., pp. 554–557, 21 Sept., 1863, from which it would appear that a young stem, two to three weeks old, exhibits a number of fibro-vascular bundles in the midst of an outer zone of cellular tissue, one bundle being formed opposite the innermost portion of each of the

* 'Elements,' &c., fig. 82, p. 170.
† 'Principles,' fig. 168, p. 253.
‡ 'Recherches,' pl. xiii., figs. 2 and 3, p. 110.
§ Pl. xviii., fig. 21, p. 130.
‖ 'Mémoire,' pp. 116, 117.
¶ Dickenwachsthum des Stengels . . . bei den Sapindaceen. Munich, 1864.

external groves of the stem; so that from its very earliest stage the stem exhibits all the rudiments of the lateral strands which surround the core. Around each of the fibro-vascular bundles a mass of liber is formed, at first crescent-shaped, but afterwards annular; and by the growth and union of these several parts the stem soon assumes its peculiar composite character.

Leguminosæ.—Another group of lianas, presenting some external resemblance to the sinuous Malpighiads, is met with in plants which belong to this natural order of the genera *Bauhinia* and *Schnella.* In the Brazils they bear the name of *Cipo d'Escada*, from their resemblance to a ladder, but Jussieu restricts this name to the *Schnella macrostachys.**

They are chiefly remarkable for depositing their woody fibres on two sides only of the central pith, so that their stems have a singular flat tape-like appearance, presenting in section the outline of an elongate ∞, the position of the pith being at the intersection of the two loops. The pith, however, by no means maintains its central position, for according to the researches of M. Netto, the growth of branches brings about a lateral deposit of woody matter, sometimes on one side and sometimes on the other, so that the pith soon becomes eccentric. The pith is generally in the form of a small Maltese cross, formed of two unequal arms, the longest of which lies in the direction of the largest diameter of the stem.

There are many other forms of Bauhinia, many of which will be found figured in the standard works of Lindley, Schleiden, Richard, Duchartre, &c.

Aristolochiaceæ.—It is very likely that this natural order has representatives amongst these ropes; at least to it I refer for the present two species remarkable for their very striking medullary rays.

In both species these rays proceed from the pith to the bark, increasing in breadth and volume as they recede from the pith, so that by the time they reach the bark they become of considerable thickness.

In one species, whose wood has a reddish tinge, there are about nineteen or twenty of these magnificent rays in a stem exceeding half an inch in diameter; the intermediate spaces are filled up with woody fibres in which occur large vessels. In this species secondary medullary rays rarely make their appearance. But in the other species, which has a beautiful cream-coloured wood of the shade of our common holly, secondary and tertiary medullary rays make their appearance, so that in a stem three-quarters of an inch in diameter there will be as many as thirty primary rays, and as many more secondary rays. In this, the commoner species of the two, the cortical system is much thicker than in the first-mentioned species. Both bear much resemblance to a wood-section in my cabinet which is called "New Zealand Pepper," a plant of which I am quite ignorant.

Ampelideæ.—Gaudichaud in his memoir† gives a figure of the *Cissus hydrophora* as one of the common lianas of the Brazil, but I am not sure whether it occurs amongst the ropes which reach this

* 'Mémoire,' p. 118. † 'Recherches,' pl. xiii., fig. 5, p. 109.

country. It is described by M. Netto,* and a short summary is worth transcribing, as he had the advantage of studying the living plant.

In the section of a young stem, beginning with the bark, we have first a suberous layer, then a thick cellular layer containing very little chlorophyll; and having at the side nearest the bark a mass of dotted cells whose walls become very thick. On the inner edge of this cellular layer we meet with a number of liberian bundles in front of some woody bundles; the latter are strikingly subdivided by the adjacent parenchyma into separate groups so as to cause it to look more like the arrangement generally seen in a monocotyledonous plant.

M. Netto mentions that the structure of the woody mass is even more remarkable, since in the place of the ordinary medullary rays, cellular bands are projected from the bark towards the pith which form cortical rays. Another peculiarity of the woody part is that, notwithstanding it may be two years old, the woody fibres are so loosely held together that they readily detach themselves from the cellular tissue in which they are imbedded. The stem must be at least three years old before it attains anything like consistency; this weakness, as contrasted with other lianas, probably leads to its not being so frequently used for packing purposes.

There is one histological character, however, presented by this liana which will lead to its identification, and that is the abundant quantity of raphidian crystals contained in all parts of the stem. M. Netto describes the form of these crystals as needle-shaped, but bifurcate at one extremity—which is peculiar.

However abnormal many of the stems belonging to these various orders may become, and however difficult it may be to trace their divergency from the normal structure, there can be no doubt that the characteristic elements of the dicotyledonous stem are all present during some portion of their lives. Their unequal development may be brought about either by the vital energy of the growing tissue of the bark being in excess of that of the wood, or *vice versâ*, from which circumstance will arise the curious outlines presented by the relative distribution of each; or else it may be produced by a much more copious deposition of woody tissue at some points of the circumference than at others, from which evil will result the curious forms presented by the Bauhinias and many of the Malpighiaceæ.

The monocotyledonous division of the vegetable kingdom has also its representatives amongst these ropes. There are two species, perhaps belonging to the grasses, which I have met with; but in neither case is the entire stem used. One species is much larger than the other, their diameters being about two inches and four inches respectively; both are hollow and are divided into strips for use.

There are many other species found amongst these ropes which belong to other natural orders, such as the Menispermaceæ, Gnetaceæ, Asclepiadaceæ, &c., but our knowledge of them is too limited to assign them to their respective orders. Most of my specimens have come from cotton bales of Santos Cotton, and it would be as well to

* 'Annales des Sciences,' 5th ser. Bot. t. vi., p. 320; 'Comptes Rendus,' t. lxii., p. 1076.

keep a record of the localities from whence they are derived. I am very anxious to get some from the Pacific coast, where many species differing from Brazilian species must be found. Gaudichaud mentions the neighbourhood of Guayaquil, in Ecuador, as being particularly prolific in these lianas.

I will conclude with a notice of another species which was sent me from the Liverpool docks by Mr. Griffiths, whose structure is so puzzling that I know not whether to call it dicotyledonous or monocotyledonous. It consists of a central spongy mass of woody tissue apparently without medullary sheath, pith, or medullary rays, and arranged in the form of a pentagon formed of semicircular lobes, the whole being surrounded with what appears to be liber which has shrunk away from the very thick and hard external bark, so as to leave the woody core isolated within it. The core consists of woody fibres, but half its area is taken up with wide-mouthed vessels.

I may add that the whole of these lianas furnish beautiful objects for the microscope.

Mr. Forrest suggested that useful dyes might be obtained from the plants described by Mr. Bailey.

In reply to a question from the Rev. Brooke Herford, Mr. Bailey stated that owing to a difference in the structure and general appearance of some of the stems in his possession he had been led to suspect that they were aërial roots of some of the plants he had exhibited and described.

Microscopical Society of Liverpool.

The second meeting of the present session was held at the Royal Institution on February 1st.

The Secretary read a letter from Mr. Richter, forwarded by Mr. T. J. Moore, descriptive of his published photograph of Infusoria.

Dr. Rickard then exhibited Mr. Richter's photograph on the screen, by means of the oxyhydrogen light, after which a paper was read by Mr. G. F. Chantrell, "On Winter Fishing in the Windsor Reservoir." The author, after a brief description of the reservoir of condensed water at the Liverpool Corporation Pumping Station at Windsor, enumerated the various species of Infusoria and Rotifera which he had found in this pond on *Anacharis alsinastrum* and *Potamogeton crispus* throughout the winter.

Of the species illustrated in Mr. Richter's photograph, Mr. Chantrell stated that he had found within the last fortnight, and chiefly in the lukewarm portion of the reservoir, *Rotifer vulgaris*, *Dinocharis tetractis*, *Pterodina patina*, *Floscularia ornata*, *Macrobiotus Hufelandii*, *Stentor Mülleri*, and *Vorticella nebulifera*; and at an earlier period he had also found *Stephanoceros Eichornii*, *Melicerta ringens*, *Aecistes longicornis*, and *Cothurnia imberbis*.

Other species, not figured by Mr. Richter, that were found in the same place during the winter were, *Floscularia cornuta*, *Brachionus urceolaria*, and *B. Bakeri*; *Scaridium longicaudam*, *Epistylis nutans*, and *E. anastica*; *Actinophrys Eichornii* and *A. Sol*; *Podophrya fixa*, *Acineta* *tuberosa*, *Vorticella microstoma*, *Vaginicola crystallina*, *Kerona mytilus*, *Astasia limpida*, *Amœba princeps*.

The paper was illustrated by large drawings from life of the various species alluded to.

A very beautiful Rotifer, not figured either in Pritchard or the Micrographical Dictionary, was also described by the author, its cilia being as fine as those *Melicerta ringens*. It is generally found ensconced in a gelatinous matter, combined with decayed vegetable substance, in the fork of the leaves of Anacharis.

The habits of a voracious parasite, *Trachelias vorax*, which attacks *Brachionus Bakeri*, were illustrated by diagrams. The Trachelias in a quarter of an hour entirely destroys the interior of the Rotifer, and leaves only its empty shell; and in one instance the Trachelias was seen to divide itself into four while in the interior of the Brachionus, quitting the empty shell in sections.

The author, in conclusion, hoped that the short sketch he had given would tend to awaken an interest in this easily accessible pond, and that other members might be induced to examine for themselves the life-history and developments of these interesting living forms.

The meeting concluded with the usual conversazione.

Tunbridge Wells Microscopical Society.*

The monthly meeting took place on Tuesday, March 1, at the Rev. W. W. Elwes' residence; the President, Dr. Deakin, in the chair.—The subject for consideration was *Diatoms*, which was opened by a very interesting address from the chair, explaining their peculiar structure and appearance under the microscope, and their mode of reproduction. Some very beautiful specimens were exhibited. The same subject will be pursued at the next monthly meeting.

Two new members were elected.

Aberdeen Microscopic Society.†

The Aberdeen Microscopical Society met in the grammar-school on Tuesday, 8th March, Dr. Ogilvie in the chair.—After the ordinary business, Mr. Clark and Mr. Leys occupied the evening. the former on the classification and arrangement of the Society's Cabinet and Catalogue, the latter on the Sea Urchin (*Echinus lividus*), giving a brief outline of the shell spines and other appendages of the skeleton. He then described his mode of cutting and grinding the spines as longitudinal and transverse sections. After some remarks by the chairman and other of the members, a vote of thanks to Messrs. Clark and Leys was unanimously recorded.

Reading Microscopical Society.‡

15th March, 1870.—Captain Lang presided, and exhibited specimens, mounted in balsam, of his *Difflugia triangulata*, and of another

* Report supplied by Rev. B. Whitelock.
† Report supplied by Mr. W. J. Johnston.
‡ Report supplied by Mr. B. J. Austin.

flask-shaped species, still unnamed, as far as he is aware. In both cases the surfaces of the tests, which are evidently of a chitinous and not siliceous nature, have a beautifully-regular, hexagonal reticulation.

It is a curious fact that, though the bodies of such animals appear to be nothing but sarcode, and though the specimens shown had been subjected to the intense heat of the flame of a spirit-lamp, yet, in each case, the scarcely-shrunken body of the animal could be seen suspended within the diaphanous test, exactly as in its living retracted state, but surrounded by a ring of agglomerated thorn-shaped particles, apparently of a denser nature.

Captain Lang at first thought these were Diatoms on which the creatures had fed, but examination proved that they were not; and as this outer ring is present in each specimen, and of similar form, it is not likely to be expressed food.

Collins' dissecting compound microscope, with erecting prism, and Möller's *test-slide*, were brought before the notice of the meeting; and specimens of *Podocystis spathulata*, *Asterionella*, parasite of owl, elaters and spores of *Pellia epiphylla*, were exhibited by various members.

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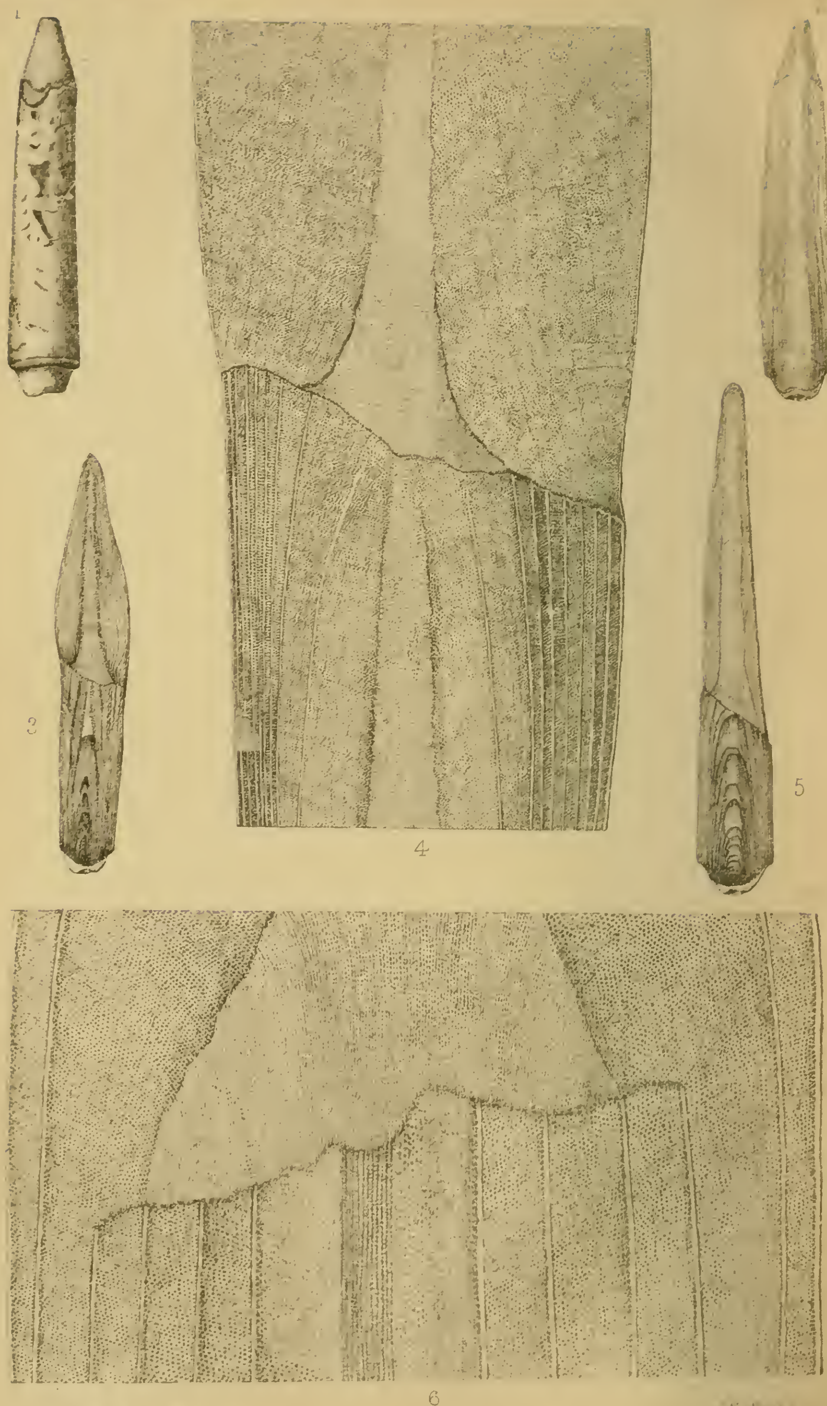


Tuffen West

THE

MONTHLY MICROSCOPICAL JOURNAL.

MAY 1, 1870.

I.—*On the Reparation of the Spines of Echinida.*

By W. B. Carpenter, M.D., V.P.R.S.

(*Read before the* Royal Microscopical Society, *March* 9, 1870.)

Plate XLIX.

In my 'Report on the Microscopic Structure of Shells' communicated to the British Association in 1847, in which the first detailed account was given of the structure of Echinus-spines derived from the examination of *transparent* sections,* I described and figured appearances † which seemed to me to indicate that a power of reparation exists in these bodies, notwithstanding the very small amount of soft tissue they contain when living, and the remote connection which this has with the nutritive apparatus. I further expressed the opinion that the reparation is effected by the *investing membrane* of the spine, which appears not only to possess the power of depositing new concentric layers of the calcareous

EXPLANATION OF PLATE XLIX.

Fig. 1.—Spine of *Echinus trigonarius*, showing partial reparation at its truncated extremity.

,, 2.—Section of a similar spine, showing the termination of the pillared structure at the line of demarcation between the stump and the new growth.

,, 3.—Section of a spine of *Acrocladia*, showing the derivation of the new growth from the outer layer of the stump.

,, 4.—Portion of a transparent section of the same spine, through the line of fracture, magnified six diameters.

,, 5.—Section of a spine of *Echinus trigonarius*, of which the normal length and shape have been almost entirely restored by a new growth.

,, 6.—Portion of a transparent section of a spine of *Acrocladia*, through the line of fracture, magnified thirteen diameters; showing the contrast between the pillared structure of the stump, and the simple reticulation of the new growth.

* The fullest description previously given of these beautiful structures was that of Professor Valentin, in his 'Monograph on the Anatomy of the Genus Echinus.' Neuchatel, 1842.

† *Loc. cit.*, § 115, Fig. 65, *d d*, *e e*.

network, like the concentric layers of Exogenous stems, at certain regular periods, but also to have the power possessed by the mantle of Mollusca of furnishing an extraordinary supply of the requisite materials when they are required for the reparation of an injury.

Not very long afterwards, my friend Mr. John Quekett showed me a specimen of *Echinus trigonarius* in the Museum of the Royal College of Surgeons, which had sustained an extraordinary mutilation; a large proportion of its spines having been broken or cut across, apparently by the bite of some strong-toothed fish, such as a *Scarus* or *Sparus*, of which the stumps that remained also bore marks, as shown in Plate XLIX., Fig. 1. Many of these spines had the conical termination here represented; and I was at once impressed with the conviction that this termination was a new growth, produced by the reparative power inherent in the organic substance of the spine. This conclusion became a certainty when a longitudinal section was made of one of these conical-tipped spines (Fig. 2); for it then became obvious that the regular pillared structure was terminated at the base of the cone by an abrupt line of demarcation, and that the substance of the cone was formed of that simple or non-differentiated calcareous reticulation, which, as I showed in my 'Report,' constitutes the elementary type of the skeleton of Echinodermata generally—a generalization which all subsequent observations on its character have tended to confirm.* It further appeared from this section that the new growth proceeds mainly, if not exclusively, from the outer layers of the spine; a distinct continuity of structure being there traceable, whilst there is a complete interruption between the calcareous reticulation of the central part of the base of the cone and that of the truncated end of the spine on which it rests.

An account of these spines, with some details of the structure of their new growths, was given by Mr. Quekett, in his 'Histological Catalogue of the Museum of the Royal College of Surgeons;'† and this was repeated in his 'Lectures on Histology,'‡ with a notice of two spines that had subsequently come into his possession, one of which showed a new growth 1½ inch long, so nearly replacing the part that had been lost as to restore the general form and proportions of the spine; whilst in the other there was seen on vertical section the evidence of four successive reparations. Though his sketch (Fig. 123 B) of this last specimen plainly indicates that these reparations were effected by ingrowth from the superficial layers, he does not notice the circumstance; but remarks (p. 228) that he has not been able to find, by treating with acid spines that have never

* See Chap. XII. of my 'Microscope and its Revelations;' Mr. James Salter's Memoir "On the Structure and Growth of the Tooth of Echinus," in 'Philos. Transact.' for 1861; and my own Memoir "On the Structure, Physiology, and Development of *Antedon rosaceus*," in 'Philos. Transact.,' 1866.

† Vol. i., p. 304, plate xv., fig. 18.

‡ Vol. ii., pp. 229–231.

been dried, any trace of the soft cuticular investment which has been stated by most writers on the anatomy of the Echinodermata to cover not only the surface of the shell but that of the spines. In this remark, as will presently more fully appear, I now entirely concur; my former assumption that the reparation is effected by the investing membrane of the spine having been based, not on my own observations, but on the doctrine then current as to the existence of such a membrane.

Before the publication of Mr. Quekett's description, I had made sections of several spines which I had obtained from different Museums, showing external appearances more or less distinctly indicative of reparation. One of these (Fig. 5), from a specimen of *Echinus trigonarius*, very closely resembles the spine figured by Mr. Quekett, in Fig. 123 A of his 'Lectures on Histology.' The new growth is nearly 2 inches long; and only differs externally from the basal portion of the spine, in being of rather smaller diameter. The principal part of it is composed of the ordinary calcareous reticulation, which has obviously grown inwards from the outer layers of the basal portion; but this is covered with layers of the pillared structure, continuous with those of the basal portion, showing that the new growth, as originally formed, has been invested by exogenous layers produced in the ordinary mode. Another spine (Fig. 3), which I obtained from a large *Acrocladia*, has a new growth 1¼ inch long; but this has a pointed shape, very unlike the cylindrical or somewhat club-shaped figure of the ordinary spine. A transparent section of this spine, of which a portion is represented in Fig. 4, enables the derivation of the new growth from the outer layers of the stump to be very clearly traced. And the same is the case in another spine, also from an *Acrocladia*, of which a portion is represented in Fig. 6.

In my Memoir on *Antedon rosaceus* * I have stated that the reticular calcareous skeleton of that Crinoid, when a fresh specimen is treated with dilute nitric acid, is found to possess a homogeneous organic basis, apparently of a sarcodic or protoplasmic character; through which are dispersed little granular glomeruli, that seem to have occupied the open spaces of the reticulation, and are partly composed of oil-molecules. By treating the spines of freshly-captured *Echini* in a similar manner, I have found them also to possess a similar organic basis-substance; and it can scarcely be doubted that it is in the portion of it which occupies the interspace-system of the calcareous network, which is continuous throughout the spine, that the formative capacity resides; that which forms the basis of that network, when once consolidated by calcareous deposit, probably losing its reproductive power. Now in the small and simply constructed spines of the *Echinus miliaris* and *E. Flemingii* of our own coasts, in which alone I have as yet examined this

* 'Philos. Transact.' for 1866, p. 703.

basis-substance, it seems to be diffused throughout the spine, though more tenacious and membrane-like in its external portions. But in the large spines of those species which add layer to layer by exogenous growth, it seems to me not improbable that the sarcodic basis-substance may after a time cease to occupy the interspace-system of the older and inner portions of the spine, and that it may be for the most part restricted to the newer and outer layers; just as we know that in an ordinary Exogenous stem, the outer layers only of the wood take an active part in its functional changes. And it is a confirmation of this idea, that such is certainly the case in the segments of the arms of the fully-developed *Antedon;* in which I have often found the sarcodic basis-substance, after the decalcification of the segment, to form a mere shell,—scarcely any trace of it being discoverable in the interspace-system of the central part of the calcareous reticulation. And thus, although the notion of an "investing membrane" to these spines, performing the functions of the periosteum of bone, proves to be fallacious, we seem justified in regarding the organic basis-substance of their outer last-formed layers as the part essentially concerned in effecting these remarkable reproductions. The marvel is that they should be able to derive the materials of their work from such a remote source as the nutritive apparatus within the shell, no vessels of any kind having been found to pass through its walls to convey nutrient fluid to the spines borne upon its exterior.

II.—*On the Colouring Matters derived from the Decomposition of some Minute Organisms.* By H. C. Sorby, F.R.S., &c.

(*Read before the* Royal Microscopical Society, *April* 13, 1870.)

The Rev. J. B. Reade, in his address as President of the Royal Microscopical Society, when speaking of the blue dichroic fluid exhibited at the last soirée, said that I had clearly proved that a very different spectrum is produced by the addition of albumen to the confervoid mass, to that formed without any such addition. Since these substances have excited much interest, and are moreover a very good illustration of the value of studying the various changes that occur on slow decomposition, it may perhaps be well to publish an account of the facts which led me to communicate my conclusions to Mr. Reade.

The first specimen I examined was a portion of that exhibited at the soirée of the Microscopical Society in 1867, the spectra of which were described by Mr. Browning in the 'Quarterly Journal of Microscopical Science' for the following July. My observations entirely agreed with his, in showing that the transmitted light contained two well-marked absorption-bands, one in the orange, and the other in the yellow end of the green; and there appeared to be no reason to suspect that these two bands were due to two independent colouring matters. Such, however, turns out to be the fact, as I have since been able to prove by a comparison of the blue fluid formed by the decomposition of the confervoid mass in water alone, with that due to decomposition along with albumen.

I was indebted to Mr. Bohler for a most excellent specimen of the colour formed without albumen, by the decomposition of the confervoid growth from a spring depositing much carbonate of lime, which occurs in the valley of the Wye below Kingsterndale, near Buxton. It transmitted a magnificent blue light, and reflected a fine red, owing to its being very fluorescent. The spectrum of the transmitted light showed a single dark absorption-band in the orange, lying just on the red side of the line D. There was a slight shading from it to the yellow end of the green, whilst the extreme red and the whole of the blues were very bright. This absorption-band corresponded in position and width with that which occurred in the orange, in the case of the specimen first examined and described by Mr. Browning and myself, but the second band was entirely absent. When examined by a strong side illumination in a narrow tube fixed into a brass foot with black sealing wax, so that no light not dependent on fluorescence could pass up the instrument, the spectrum showed that the extreme red was very bright, but the blues very dull, and the absorption-band was only just visible.

Through the kindness of Mr. Reade, I was able to examine a second specimen due to decomposition along with albumen. Originally it was of a purple-blue colour, but after keeping it for a couple of months in a corked bottle it had become a fine pink by transmitted light, with strong fluorescence of orange-red colour when illuminated at the side. The spectrum of the transmitted light showed only one absorption-band, extending from just beyond D over the yellow end of the green, corresponding in position and width with the second band in the colour first described by Mr. Browning and myself. The red and orange were quite free from absorption, but the blue rays were only partially transmitted when the thickness of the solution was considerable. The spectrum of the light of fluorescence showed a very bright narrow band in the yellow, just on the green side of the line D, the green and blue rays were absent, and the red comparatively faint. Adopting as the scale of measurement the interference spectrum described by me in previous papers, which divides the visible spectrum into twelve portions of equal optical value, and is so adjusted that the line D is situated at 3½, and F at 7½; and expressing the intensity of the absorption, whether slight, moderate, or great, by dots, hyphens, or dashes respectively, which when printed *between* numbers signify that there is a more or less strong absorption between those points in the spectrum, as measured by the scale, and when printed *under* numbers signify that there is a more or less distinct absorption-band, the *centre* of which is situated at the point indicated by the figures, we may express the above-named spectra in the following manner, so that they may be easily compared:—

	Spectrum of the transmitted Light.	Spectrum of the Light of fluorescence.
Decomposed without albumen	2¾ - -	2¼ — 3¼ - - - -
Decomposed with albumen	4⅛ —	. . . 3½ 4 - —
Specimen described by Mr. Browning and myself ..	2¾ 4⅛	. . . 2¼ — 3½ - - 4½ —

It will thus be seen that the spectra of the blue colour prepared without albumen are quite different from those of the colour produced by keeping for a few months with albumen, whilst the spectra of the original blue colour are precisely like what would result from a mixture of these two. On keeping the colour formed without albumen for about nine months in a corked bottle no pink colour was developed. It gradually became paler, and at length greenish brown, showing a mere trace of the original absorption-band, but no other; and hence it should appear that the pink colour is not formed by the simple decomposition of the blue. In a similar manner the pink solution gradually faded to pale orange, even when hermetically sealed, and showed only a faint trace of the band originally seen in the green. On the whole, therefore, the facts seem to show that when decomposition takes place with much albumen present, both colours are generated, and then the blue is decomposed in such a manner that the pink colouring matter is left by itself; and thus we have a good illustration of the value of studying the changes that occur during slow decomposition, and of the importance of our carefully examining whether any particular spectrum is due to a single substance or to a mixture of several.

Since writing the above, Mr. Sheppard has kindly sent to me a specimen of the liquid prepared with casein. This gave a spectrum with the same two absorption-bands as when albumen had been used. Having thus, as I believed, proved that it was a mixture of the two coloured substances, I thought it would be interesting to ascertain whether they could be separated, or one decomposed without changing the other. After trying various experiments, I found that by mixing the liquid with an equal bulk of absolute alcohol a precipitate was formed; and when this had been removed by filtration, a clear pink solution was left, which gave exactly the same spectrum as that of the pink colour obtained by slow decomposition, as described above. On evaporating this alcoholic solution at a gentle heat, so that nearly all the alcohol was removed, and a more concentrated aqueous solution left, I was able to examine the spectrum to greater advantage than heretofore. The transmitted light showed the narrow and dark absorption-band at the yellow end of the green, and also another, very faint, nearer the centre of the green, but there was no trace of a band in the orange. The light of fluorescence gave a single, narrow, bright-yellow band. These different bands corresponded in every respect with those characteristic of the pink colour already described, and also with the equivalent bands in the spectra of the mixed liquid. The alcohol seems to decompose the blue colour; for when the precipitate was redissolved in water, only a turbid brownish-grey liquid was obtained.

On agitating the mixed solution with ether, it rose to the top coloured pink, leaving the water blue; but the separation is unsatisfactory, on account of both solutions being very turbid, and the colouring matter in great measure precipitated.

Through the kindness of Mr. B. D. Jackson, I have also been able to examine another specimen of the blue fluid, prepared without albumen or casein. This gave, like the specimens previously examined, a single absorption-band in the orange, but none in the green; and thus it appears that the production of the pink colour depends on the presence of albumen or casein in a state of decomposition, and whatever difference there may be in the result is apparently due to a variation in the relative amount of the two colours.

III.—*Cercariæ, parasitic on Lymnæa Stagnalis.*

By Jabez Hogg, Hon. Sec. R.M.S., &c.

(*Read before the* Royal Microscopical Society, *April* 13, 1870.)

Plate L. (upper half).

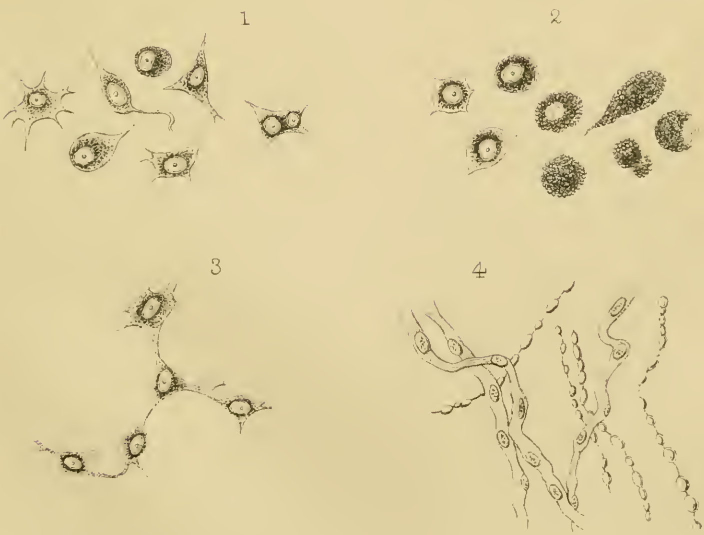
The superior means, and increased facilities, for microscopic investigation which we now possess, over observers of a former generation, offer some temptation to young and enthusiastic workers to go over ground apparently exhausted, or at least well worked. This is often useful, if for no other purpose than that of comparing notes, weeding out supposed new species, rooting out old theories, and perchance clearing up some obscure or doubtful point in the history of an animal or vegetable. It will be readily conceded that owing to the imperfections of the instrument employed up to within the last quarter of a century, and the method of preparing and mounting objects, many inaccuracies have crept into our scientific descriptions, and have been accepted for no better reason than because presented under the authority of some well-known name.

Such thoughts were passing through my mind as I was leisurely observing the movements of some water-snails near the edge of the lake in the Botanical Gardens towards the end of the autumn of last year. I stooped to pick up a fine specimen of *Lymnæus stagnalis*, and observed suspended from its pulmonary cavity a mass of minute thread-like bodies, which my pocket lens enabled me to determine were of a parasitic nature. I put the specimen in my pocket, for more careful examination at home. Before depositing the snail in my aquarium, I gently detached a few of the little animals, and put them into a shallow cell. On viewing them with a half-inch objective I was arrested by their wonderful activity; they plunged in the water and lashed it about in their wild attempts to escape. Finding all efforts to do so impossible, they violently tore their tails from their bodies, swam about for a few moments, even more vigorously than before, and at length growing weaker, died apparently from exhaustion. I had no doubt that my specimens were the larvæ of a trematode worm; but as I had not previously seen any exactly like these, which differed in some particulars from those figured by various authors, and was so very different from one given in my paper "On the Water-snail,"* I was rather inclined to believe I

EXPLANATION OF PLATE L. (upper half).

Fig. 1.—Cercaria furcata, seen when first removed from the Lymnæus.
„ 2.—A profile, or side-view, of animal at perfect rest, and suddenly killed.
„ 3.—Seen in the act of breaking or dividing into two portions.

* 'Trans.,' vol. ii., p. 102, 1854.



Tuffen West Sc. W. West. imp

Cercariæ —— Regeneration of nerve-structure.

had discovered a new species. My search for either a description or drawing was unavailing, until Dr. Baird directed my attention to Dr. Nitzsch's small volume, in which I found a very badly-drawn specimen of *Cercaria furcata*, somewhat resembling mine. It is there grouped among some strange companions, and seemingly placed by this author among infusorial animalcules. It is quite unnecessary to dwell upon the remarkable metamorphoses which trematode *Entozoa* undergo during development into flukes; but as every species of animal appears to be liable to be infested by a fluke, it will, I am sure, be considered not out of place if I attempt to call more particular attention to a point or two in the history of this cercaria which I think has hitherto not been dwelt upon with sufficient care.

Early writers on the parasites of molluscs look upon them as a disease, and this view is held to the present day. It is, however, somewhat remarkable that the hundreds of these little animals which are seen to cluster around the body of the strongest and healthiest snails, produce no apparent discomfort to their nurses. They likewise take possession of the smaller and younger snails, whose growth is in no way impeded, nor health deranged; but after having completed this phase of existence, they are weaned without difficulty, and only wait the opportunity to begin a new life in the stomach of a higher order of animals. When the snail is kept in a confined space, and without a sufficient supply of vegetable food, the cercariæ slip from their hiding place, swim about freely, and are soon lost sight of; this would scarcely be the case if they sucked their nurse and depended upon her for nourishment. It is questionable, then, whether it is right to regard their presence as a condition of disease; possibly, they bear no other relation to an abnormal condition than the spores of the mushroom do to the stomach of the horse, through which viscus they must pass before they are in a fit state to germinate. Réaumur took cercariæ to be "mites;" Müller, "worms." The latter called them "*vibrio Malleus;*" Bory "*Histrionella fissa;*" and Steenstrup first noticed their transformation to Distoma.

Among the earliest writers who seem to have understood these curious hair-like worms, was Dr. Christian Ludwig Nitzsch, who in 1817 published a small monogram, entitled 'Bertrag zur Infusorienkunde oder Naturleschreibung der Zerkarien und Bazillarien.' Among other badly-executed drawings of infusorial animalcules is one which is intended to represent *Cercaria furcata.* Its peculiar forked-like tail is almost sure to induce anyone who sees it for the first time, to think that it should be properly placed among Rotifers. V. Bäer in an excellent paper* enters more fully into the peculiarities of this species, and of the various forms it assumes. He discovered cercariæ on *Paludina vivipora.* Diesing, in his 'Systema Helminthum,'

* Nov. Act. Nat. Cor. xiii. 2. p. 627. 1827.

1850, shortly describes it among twelve other species, under the name of "*Malleolus furcatus Ehrenberg. Corpus* elongatum depressum, *Os* subterminale, *Acetabulum* centrale tubuliforme, *Cauda* teres simplex, *Apice* furcata. Habitaculum Limnæus stagnalis."

Siebold described a species of cercariæ, which he says are to be seen in thousands upon specimens of large fresh-water snails, the body of which is of an elongated form, head triangular, and ventral sucker scarcely visible. The swimming movements are restless and characteristic, and chiefly performed by the tail. The tail tapers from the body downwards, but is not acutely terminated. This member is thrown off in its change to the fluke. It is, I believe, the remarkable way in which these creatures when in a confined space are seen to break off this appendage, which has led to a belief that the tail is not absorbed into the body of the future animal in its subsequent metamorphosis, as we know occurs in the analogous transformation of the tadpole into the frog. I venture to think Siebold's description in this particular an error. Some naturalists say the ova of cercariæ are developed within the body of the snail; this is scarcely consistent with what is stated regarding the healthy state of infested snails. I believe what has been seen are simply gregarinæ, which are sometimes found in abundance in the alimentary canal of the Lymnæus. The parent may find it convenient to conceal her eggs in the folds of the mantle, or in the pulmonary cavities, where they will be secured from the attacks of enemies; or they may be attached to the internal portion of the shell, just as vorticella are to the outer. I am of opinion the eggs are hatched here that the young animals may find a ready means of subsistence; a careful nurse, who gently carries them among plants which afford an abundant supply of food, and at a certain period of growth is sure to deposit them where they instinctively await the thirsty mammal, whose stomach they must occupy before they attain to a more perfect stage of development.

The nervous trunk runs continuously through the tail and body, and when the animal can be kept sufficiently still is seen to present an unbroken chain. The remarkable bi-furcated tail-like process enables this species of cercaria to move about with extraordinary rapidity of action; it is so articulated to the body, that it can be brought up to a very acute angle, and when broken off the broken extremity presents a concavity in which the convexity of tail accurately fits. The body and tail are equally active when detached from each other, and continue to swim about as if nothing unusual had happened. When exhaustion commences, the contents of the stomach are ejected through the broken extremity or the mouth, and therefore I was unable to satisfy myself whether the nipple-like process placed near the centre of the body is used as a vent. This nipple is peculiar to the species. The larva always attaches itself by this sucker to the snail, and thus its mouth is left perfectly free to secure its food. The mouth, armed with more than a pair of mandables, might be used as a formidable weapon of offence. It occurs to me that if these epiphytes were solely nourished by the snail, a colony of them must prove a formidable army of blood-suckers.

Unfortunately my further investigations were suddenly interrupted by an accident which broke the aquarium and killed the Lymnæus, and I have not since been able to renew them. But I may add, in conclusion, that I was at first inclined to regard my specimen as new. Upon a more careful comparison I am disposed to believe that it is no other than *Cercaria furcata* of Nitzsch, although from the imperfect character of his drawings I might have been betrayed into the error of supposing that I had indubitably discovered a new species.

IV.—*Experimental Researches on the Anatomical and Functional Regeneration of the Spinal Cord.* By MM. Masius and Van Lair, Professors in the University of Liege.

Plate L. (lower half).

Voit has recently proved the reproduction of the cerebral tissue in the pigeon, and the coincidence of this reproduction with almost complete renewal of the cephalic functions. The facts which we have collected tend to show that in the frog this regeneration of the spinal cord also takes place.

A certain number of authors have proved before us the *cicatrization* of the spinal cord when simply *divided*, but no one has as yet observed the *reproduction* of a segment of *excised* cord. We thus formulate the principal deductions which have resulted from our experiments.

The spinal cord in the frog can recover instantaneously a loss of substance which has taken place in its own tissues, and repair its primitive anatomical and physiological properties. The grounds upon which we base this assertion are of two kinds, *anatomical* and *physiological.*

I.—Anatomical Facts.

The reproduction of the nervous elements takes place very rapidly. This we have observed in a frog which had undergone the excision of a medullary segment of 2 millimètres in size, a month after the operation. The two ends are united by a cylindroid mass of yellowish translucent substance. A portion of this gelatinous substance examined under the microscope mounted in serum shows:—

1. Very delicate cellules, some of which appear *spherical* or *ovoid*, and devoid of prolongations. Some of these are bipolar, whilst others possess prolongations which can sometimes be traced easily from one cellule to another. All the cellules are composed of a finely granular protoplasmic mass, of a relatively large spherical or ovoid refractive nucleus, surrounded by a membrane with very clearly defined double contour.

The *nucleolus* is brilliant, small, spherical, and always very apparent, the prolongations are fine and pale, and appear to proceed from the protoplasm (Fig. 3).

EXPLANATION OF PLATE L. (lower half).

Fig. 1.—Nerve-cells of forms met in the gelatinous substance, magnified 350 diameters.

" 2.—The same, undergoing pigmentary degeneration × 350 diameters.

" 3.—Cells of the gelatiniform substance with their anastomosing prolongations × 350 diameters.

" 4.—Fibres of Remak and varicose fibres found in the gelatinous substances.

These are the sizes of these elements:—

		Millimètre.
Spheroid and stellate cellules:	diameter of the cellule	0·0128
„ „	„ nucleus	0·0096
„ „	„ nucleolus ..	0·0016
Bipolar cellules:	great diameter	0·0208
„	small diameter	0·0080

These cellules are perfectly identical with the cellules taken from different portions of the grey substance of the spinal cord in healthy frogs. These are therefore nervous cellules. They differ in nothing from the cells of the *human* cord, save in some secondary characters; they are smaller than the latter, but this reduction affects only the protoplasm; the mean dimensions of the nucleus are nearly equal to those of the human cord cells.

2. Besides the preceding cellules we find corpuscles of different dimensions (but nearly always greater than those of the cellules); they are generally of a round form, and are composed of an accumulation of angular granulations of a deep yellow, or sometimes even quite black colour. These are very probably *nervous* cells attacked by pigmentary metamorphoses (Fig. 2).

3. Certain elements intermediate between the two preceding. Some of these are like nerve-cells, devoid of prolongation, but already containing, grouped around the nucleus, granulations like those which compose the large pigment corpuscles. The others, larger and apolar, are almost completely invaded by the pigmentary matter; the nucleus appears as a circular uncoloured spot, and the nucleolus has disappeared.

4. Thick and slightly-flattened fibres, in which may be seen elongated nuclei. In all respects they resemble the fibres of *Remak.*

5. Slender varicose fibres, far less numerous than the preceding. They are identical with the amyline fibres of the nervous centres.

If one completely removes the gelatinous substance which unites the ends of the cord, it is found that the two surfaces of the section have changed form. That of the cephalic extremity of the cord is in some measure *etalée*, and recalls the appearance of the surface of the section of a healthy cord still surrounded by its *pia-mater.* The caudal end affords an opposite form, and resembles a sort of stump (*moignon*).

Microscopic examination shows in both ends of the cord alterations which extend to two *millimètres* beyond the surface of the section. The large fibres appear still normal; but the slender fibres are more varicose, and are nearly entirely decomposed (near the surface of the section) into globules of myelene. The cellular elements present the same appearances as the cells which are met in the uniting gelatinous substance.

II.—Physiological Phenomena.

The physiological phenomena are more marked even than the anatomical observations.

A certain number of frogs selected for these researches were operated on below the reflex centre of the roots which compose the sciatic plexus in a manner to destroy all spontaneous and reflex mobility in the hind limbs. Another series were operated on above this centre so as to preserve the reflex mobility.*

In both cases, at the end of a month, we have seen the voluntary movements reappear in the previously paralyzed parts, and the *conscient* sensibility soon after exhibits itself. At the end of six months the frogs move away spontaneously, and perceive impressions just as they did before the operation. The portion of the cord removed was about two millimètres.

The conclusions to be drawn immediately from our researches are the following:—

1. The spinal cord in the frog may repair the loss of substance sustained in its proper tissue by the aid of a new medullary tissue.

2. The return of the functions of the cord which had been suspended by the operation coincides with the regeneration of its anatomical elements.

3. This anatomical and functional regeneration takes place gradually. In the histological repair it is the cells which first appear, and the fibres after. And in the case of the functional repair it is voluntary motility which is first restored.

If now we proceed to an analysis of the data furnished by our researches, we are led to compare the mode of regeneration of the cord with that of the brain and of the nerves. In regard to the anatomical conditions, the reparation of the cord resembles that of the brain—as Voit and Kollman have demonstrated it—by the new formation of nerve-cells in the reparative tissue; but it offers a still greater analogy with the reproduction of the nerves (as described by Schwann, Vulpian, Philippeaux, Robin, and Laveran), because of the funicular form of the new tissue which removes the "solution of continuity," and by the appearance of the two surfaces of the section in the first phase of regeneration.

As regards the physiological phenomena, the reappearance of the conductibility of the cord for voluntary impressions tends to assimilate the cord to a *root* of a spinal nerve, whilst the alterations found in the two segments of the cord demonstrate that the portion of the cord remaining takes up—with regard to the elements anterior and posterior to the part excised—the functions of a nutritive centre.

The method of regenerating the cord would therefore occupy an

* These researches are to be found in a memoir entitled 'De la Situation et de l'étendu des autres réflexes de la nouvelle épinière chez la grenouille.' Extrait des Mémoires de l'Académie Royale des Sciences de Belgique, t. xxi. 1870.

intermediate position between the regenerative process of cerebral matter, and that of the nerves. However, if we consider the general configuration of the cord, and the clearly-marked difference between the forms of the two medullary ends during the early period of the reparative process; if we remember that the *initial* phenomena, which have revealed the existence of a nervous union, were almost exclusively phenomena of conductibility; if, finally, we consider that the white portion of the cord may, up to a certain point, be compared to bundles of roots, we shall be disposed to group the regeneration of the cord with the reproduction of the nerves, rather than with that of the cerebral hemispheres. *The brain would then fulfil, with respect to the cord (so far as the regeneration of the latter is concerned), the same function that the cord fulfils with respect to the rachidian nerves.*

We have yet to explain certain peculiarities noted in our observations.

1. The difference proved to exist between the date of the return of voluntary *motility,* and that of conscient *sensibility.*

The theory of *trophic centres* may give us the key to this fact. The spinal ganglia are, in fact, looked upon as the nutritive centres of the sensitive rachidian fibres, while the cord is the common nutritive centre of the anterior roots. It is extremely probable that the same holds good with regard to the two kinds of *intra-medullary* fibres which constitute in the interior of the spinal axis the direct or indirect prolongation of the roots. Now, in every transverse section of the cord, affecting at the same time a sensitive root between its medullary insertion and its spinal ganglion, the fibres that remain attached to the cord, and those also which continue the root into the cephalic segment of the cord, will cease to be in communication with their trophic centre (the spinal ganglion), whilst, on the contrary, the corresponding motor fibres will not have been separated from their centre (the grey matter of the cord). We can now understand that the intra-medullary motor fibres degenerate less and are repaired more quickly than their neighbours; which explains the earlier return of voluntary motility.

2. The presence in a tissue invaded by a neo-formative process, of cells laden with pigment and *frappées d'inertie.*

This fact is not surprising, seeing that nervous cells present, even in the physiological condition, a great tendency to pigmentation, and that besides, a necro-biological action is almost always found combined with the neo-formative process. In a process closely related to this—the regeneration of the nerves—the two phenomena are constantly observed progressing simultaneously.

3. The predominance of the *cellular elements* in newly-formed tissue, and the maturity of those elements compared with the embryonic state of the fibres.

This circumstance may be accounted for by comparing the new matter to embryonic nervous tissue. It is well known that in the primary phases of the development of the cord, it is the cells of the grey matter that are first formed, and then the fibres.

4. The apparent improbability of the generation in an adult animal of *organites* occupying, in the series of histological elements, so high a rank as that of ganglionic cells.

This improbability disappears when we consider the favourable conditions found united in the frogs operated on, and previously-observed facts. The production is in fact entirely homoplastic, and the protection afforded to the cord by the vertebral canal prevents any external influence from checking the reparative process. Besides, Voit and Kollmann have already proved the neo-genesis of the nervous cells, and Beale has seen in the ganglia of the adult frog a *continuous* formation of the same cells.

The want of success of previous experimenters is due to their having neglected certain essential conditions, which we have ourselves been able to determine only after repeated trials.

When desirous of obtaining regeneration, we operated on active and healthy and well-nourished frogs in the beginning and middle of the winter. The operations tried in summer never succeeded.

V.—*Observations on some points in the Economy of Stephanoceros.* By Charles Cubitt, Assoc. Inst. C. E., F.R.M.S.

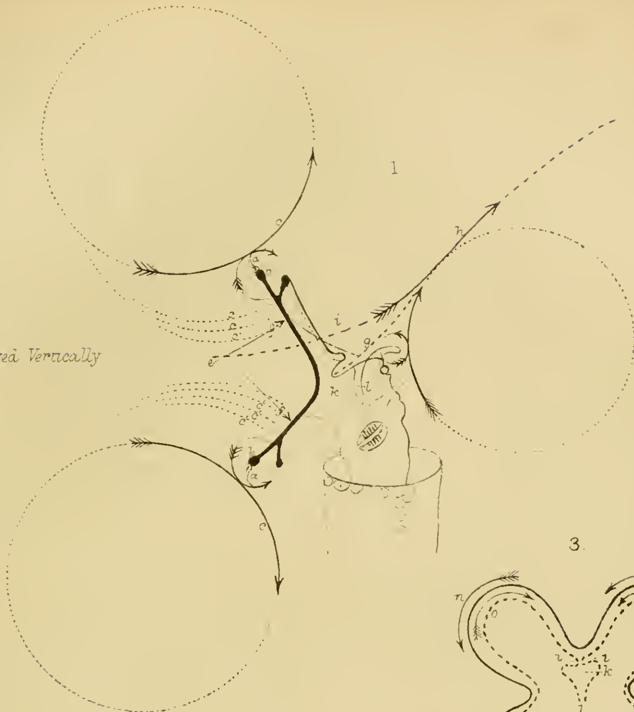
In submitting the following remarks on such a familiar subject as *Stephanoceros*, I am stimulated to offer them with some confidence on the encouraging incentive held out by Mr. Gosse to "observers with good instruments" in the closing paragraph of his description of this exquisite form, on which he says "there are many points in its economy on which we need further light;"* and to the investigation of certain points that are manifestly irreconcilable with, or unrecorded in the descriptions of himself and others, I have directed much attention; and should these remarks fall under the notice of these acute observers, I trust they will acquit me of any motive beyond a desire to eliminate a little of the light their teachings have shown us to be wanting.

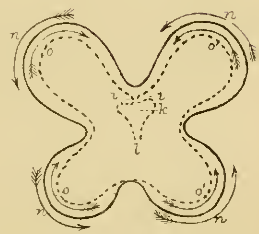
I hope to show that there exists a closer relationship between the aberrant and normal forms of the *Rotifera* than has been hitherto recognized by many who object to Ehrenberg's arrangement of the Family *Flosculariæ* on less important points than those which exist in support of the intuitive correctness of his classification.

A consideration of the functions of the *Trochal Disc* is the first

* 'Popular Science Review,' vol. i.

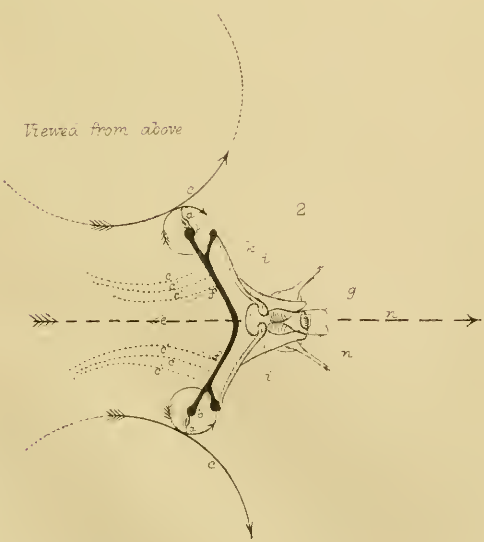
Viewed Vertically

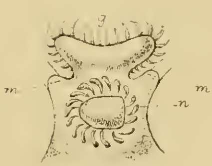




Ventral aspect.

Viewed from above





Pellet Cup

C. Cubitt del. Tuffen West Sc.

W. West imp.

Diagrams
Illustrating the Courses of the Currents produced by the Disc of Melicerta.

point, and with the view to form a true comparison with that organ of the normal forms, the nature and effects of the currents produced by their marginal cilia first claim our attention; and the diagrams (Plate LI., Figs. 1, 2, 3, 4), which were constructed in the summer of 1867 to illustrate their courses in the disc of *Melicerta* are now submitted to facilitate such a comparison; and to prevent any confusion of terms requiring to be frequently repeated throughout these remarks, it is to be understood that the word *cilia* is used to express the active vibratile hairs in contradistinction to the more quiescent *setæ*, and *bristles* as distinct from both.

In the disc of *Melicerta*, let us first consider the action of a single marginal cilium (Figs. 1 and 2, *a*, *a*). Its point describes a circle from a centre (*b*, *b*), in the direction indicated by the small arrows, which at first sight would appear to drive particles away *from*, and not *to* the ventral surface of the disc, and *in vacuo* such would be the inevitable result; but here the motion of the particle is subservient to that of the medium supporting it, in fact to the water. Consider therefore, the point of this cilium to represent one of the teeth of a small pinion working into a large wheel whose diameter is proportionate to that of the pinion inversely as the resisting power of the water is to that exerted by the cilium, and the course of this wheel will be in the direction indicated by the arrow (*c*), precisely that of the current actually produced by the motion of that cilium, by which means particles are conveyed to, and impinge on, the ventral surface of the disc at a tangent perpendicular thereto (*e*, *f*); the same thing occurs with each individual cilium all round the margins of the four frontal lobes (*c′ c′ c′*), and the lobes being deflected from the plane of the disc, form an irregular funnel, and so produce by a confluence of numerous currents a resultant volume which escapes in part through the upper sinus, and then, meeting a current from the dorsal lobe (*g*) (the chin of Gosse), is thereby deflected more or less from its primal course, according to the varying angles assumed by the frontal lobes, as indicated by arrow (*h*), passing off in a dense stream to be dispersed around or to be brought again and again unappropriated over the same course; clearly showing that the rotary organ by the currents it creates *does not* convey particles within its range to the mouth.

In considering the process by which food is actually carried to the mouth, let us see how far these marginal cilia are concerned. They possess a certain power of prehension, and are seen to *whip* those particles that, impinging on the disc, are so brought within their limited range, over the margin into the channel formed by the second range of cilia; and here their function ends. If further proof be needed, it is found in the fact that while their onward procession, or the appearance of such, is in one and the same continuous direction (Fig. 3, *n*, *n*), the particles that do find their way to the mouth course along from the lower sinus in opposite directions *o*, *o*′, and consequently could not possibly be under the influence of those marginal cilia.

The courses produced by this second range meet in confluence at the upper sinus (Fig. 3, *o*, *o*′), and their continuation to the dorsal lobe is interrupted at this point by two small ciliated processes (*i*, *i*), which exercise such marked discrimination in their rapid selection of particles from the general mass that are specially appropriate for alimentary or building purposes, and in rejecting others as waste; the whole mass passing beneath these processes into a bilateral cavity (*k*), consimilar with the "arched" pair in *Lacinularia*, and which we shall see has its representative in *Stephanoceros;* and although the whole orifice and accessory organs about the mouth appear to be one confused mass of cilia, the introduction of carmine, or even an excess of the natural materials, shows three distinct courses emanating from this cavity, first and most important the refuse, in a dense volume, passing off and blending with the current through the upper sinus (*h*); next a profuse percolation through the œsophagus (*l*) on to the manducatory apparatus, and thirdly, a comparatively sparse and tardy current, diverging along well-defined channels or chases beneath the lateral margins of the dorsal lobe (Fig. 4, *m*, *m*), passing downward into the pellet-cup beneath (*n*).

The disc of *Stephanoceros,* with its five frontal lobes, is accepted as an aberrant form of the trochal disc that characterizes the higher forms of *Rotifera;* and it is stated that these five arms act like "a common trochal disc by producing a vortex directing all particles within its range to the mouth;"* a statement based on an imperfect acquaintance with the functions of the disc, either aberrant or normal, and having already shown their extent and limit in *Melicerta,* we shall see that, though the methods here employed are in anteposition, they serve the same general purpose, there by means of the currents created by their marginal cilia, and here by means of the great expanse of their setigerous lobes placing the animals respectively in command of an extensive feeding area. They are both constituted to act as prehensive appliances, and not as the immediate cause in conducting nutritive particles to the mouth.

The action of the *Setæ* on the lobes both of *Stephanoceros* and *Floscularia* is spasmodic, it creates no vortex, and it is only by actual contact with these *setæ* that floating particles are whipped within the area enclosed by the lobes, where by the same whipping action they are twitched from point to point irregularly downwards until they come within the range of a vortex that is due, not to any action of the *setæ,* but to a range of minute *cilia* in the funnel, distinct from the foraging appliances.

In *Stephanoceros* the immediate control, together with the power

* 'Prit. Infus.,' p. 399.

of selection of various matters from the general mass, is effected by organs manifesting great similarity with those of the normal forms, first by an internal belt of cilia situated in the neck (Plate LII., Figs. 2, 3, *a, a*), springing from two ciliated processes (*b, b*), seated bilaterally in the contractile membrane which recedes from the walls of the body immediately beneath the bases of the lobes; the belt slopes at a considerable inclination, in a ventral direction, to meet and form attachment with bands descending from the two lobes that in their pentagonal disposition face the dorsal lobe (Fig. 2, *c*). From these processes clear fibres *d*, run off towards the *brain*, and are lost in the mass of that most conspicuous object (*e*). To this belt then is due the vortex that in the funnel acts as the primary process in conveying to the mouth the nutritive matters that have previously been secured and brought within its influence, and is the representative of the second range of cilia in the higher forms.

Here also we see that the particles do not pass uninterruptedly into the œsophagus; they are subjected to the same scrutiny that obtains in the higher forms, and this is here effected by similar organs. The dorsal lobe is produced in a free end or *tongue* (*f*), projecting considerably into the funnel, its under-surface is abruptly returned forming an "arched cavity" (*g*), in connection with a permanent ridge of the œsophageal septum (*h*). A similar ridge and cavity are seen on the opposite side just below the attachment of the belt with the bands descending from the ventral lobes; nevertheless these ridges are not continuous, they support the highly contractile septum at four points; and although I have not been able to detect them after treatment with potash, they represent the four hooked spines whose existence is referred to by Leydig.

Both the dorsal lobe and the ventral attachment of the belt create a considerable departure from a true cylindrical form at the neck, the dorsal lobe forming a gap in the collar, apparently to accommodate the incessant working of the *tongue* beneath, which is actively intruded on the approach of the more minute Infusorial particles which at times are retained in the cavity for periods of varying duration, and at others either swallowed or rejected on the slightest contact, apparently not requiring such careful scrutiny. In the act of swallowing, the *tongue* approaches simultaneously with the ventral projections, and in conjunction thus direct the particles to the orifice of the mouth, which is protruded to meet those projections and to pass it with that gulping action through the œsophagus on to the manducatory apparatus.

Gosse has evidently taken an "artist's licence" in representing three teeth in the detached figures of the *nucus* of this organ in *Stephanoceros*. The laws of geometrical projection show at a glance that these figures are hypothetical and do not represent the same things shown by the figure of the dorsal aspect of the jaws in the illustrations to his elaborate paper "On the Manducatory Organs of the class *Rotifera*, communicated to the Royal Society in 1856." There are only two teeth to each *uncus*, the ventral being much stronger than the dorsal tooth. They are thickened near their points, where they give attachment to membranes that connect the one tooth with the other, and form a kind of frame, hinged by one corner to one of the pair of members forming a rudimentary *ramus*, which also works on what must be accepted as a bonâ fide *fulcrum*; these together permit of a combined backward and lateral movement. The *malleus* is very distinct in the living animal, but vanishes beyond recognition on the application of a weak solution of potash, and the whole apparatus takes a skeleton appearance, the several parts at once forsaking their normal positions under such treatment, and hence the difficulty in arriving at its true character (Fig. 10).

We now come to a consideration of the visual organs, and when we find that all the facts which natural and physical science have made us acquainted with go to prove that light is absolutely necessary to organization, we may fairly assume that the development of the functional organs of animals requires in some way the influence of the solar rays, even in these minute forms, when we find them possessing organs eminently calculated to supply it, though not necessarily to ensure the perception of objects; and though the eyes of the *Rotifera* have received much attention, have been admitted to possess a refracting medium, and to be placed immediately above the homologue of the brain, the tendency hitherto has been to repudiate Ehrenberg's acceptance of them as characteristics, and to assign to them only a secondary rank as such, on account of the assumed "curious fact" of their disappearance in the adult stage of certain species.

Stephanoceros is universally understood to possess only one eye in the adult stage after having had two, both in the ova and young; even the careful observations of Gosse led him to suppose that the two eyes of the newly-hatched young became by coalescence changed into one in the adult. This is certainly not the case, they do not coalesce, or become changed by any phase of metamorphosis from their normal condition of two to a single eye; they all possess two eyes. I have during the last nine months examined some hundreds of adult specimens, and have found, without exception, two eyes.

The adult eyes are easily recognizable with the Wenham parabola, in a dorsal aspect, and with a little careful focussing in almost any other—at least as far as the red pigment spot is concerned, they require a different illumination to resolve the details. They are seated, not immediately above, nor like a wart upon it, but one on each side of the *brain*, a little below its anterior surface, as seen in a dorsal aspect (Plate LII., Fig. 1), generally in the same horizontal plane, but at times very irregularly placed, one eye being far below the other, and almost hid from view by the interposition of the granular masses that obtain on each side of the *brain* (Fig. 1, *l*, *l*).

Their true character is difficult to determine, they resemble in a marked degree the eyes of Vertebrates, consisting of a globe, sending off posteriorily a fibre to the *brain*, and possessing anteriorily a pigment spot, which, while favouring the form of the compound type (Fig. 4), contains within itself a central refracting medium; but whether this be a simple expanding orifice, like the *iris* (Fig. 7), or annular (Fig. 5), or whether it consist of a number of facets, like the compound eye (Fig. 6), I am somewhat doubtful: these several appearances have, under conditions beyond my appreciation, presented themselves, but I believe Fig. 7 to be the true representation; of this, however, we may be certain, that whether they incline to the simple or compound type, they are eminently calculated to fulfil the purposes they are required to serve, in simply conveying light, though not the perception of objects to the *brain*, for they possess no *choroid*.

I will take this opportunity of mentioning that, amongst other *Rotifers*, I find *two eyes* in the adult *Floscularia coronetta*, which at the date of my description* of that species I had failed to notice, owing to the tutored impression under which I then laboured as to their disappearance in the adult stage in the whole genus.

Stephanoceros manifests a marked resemblance to *Lacinularia* in the arrangement of the vessels and *sacs* composing the water vascular system, and in tracing the courses of these vessels up from the region of the cloaca, I came, to my gratification, upon a rudimentary antenna provided with the characteristic bristles, and at once found its companion on the opposite side, each in connection with a *pulsatile sac* (Plate LII., Fig. 2). From these antennæ the vessels send off anteriorily two branches, one to each of the processes of the ciliated belt (*a*), thence continuing horizontally and uniting with its fellow at the base of the dorsal lobe; the other branches run in the direction of the adjacent lobes alongside the brain and anastomose with the horizontal branch; the vessels each contain a *sac*, just below the stomach, one at each antenna, one at each of the ciliated processes of the belt, one in each of the vertical, and another in each of the horizontal branches; that is, five on each side as in *Lacinularia*.

I have adopted the term *pulsatile sac*, in preference to that of *vibratile* or *tremulous tag*, from the fact that in *Stephanoceros* they do not occur as pensile bodies projecting into the body cavity, and are not capable of being swayed about with every movement of the fluid with which the body is filled; they occur as swellings in the vessels, similar to what Huxley describes in *Lacinularia*, in which he states the flickering appearance to be produced by "a long cilium

* 'M. M. Journ.,' Sept. 1869.

attached by one extremity to the side of the vessel, and by the other vibrating with a quick undulatory motion in its cavity."* I have watched with absorbing attention this undulating appearance, and it is with much deference to such weighty evidence that I venture to suggest the possibility of such an appearance to be an optical illusion, and to be produced by a rhythmic contractility of the vessel itself; in short, by a *pulsation.*

Pulsation in the higher animals is due, if not to the direct influence of the *brain*, to an independent *nervous system* of the heart; for the heart beats long after it has been severed from the body, and any separated portion beats for a period so long as it contains its own ganglia; separate such part however, from its own ganglia, and its pulsation at once ceases; its *stimulus* is removed. Then we have the perplexing statement that *there is no evidence* of *nerves* either in the embryonic heart, or in these *pulsatile sacs* of the simpler animals. This, however, is but negative evidence; no *motion* can be produced without some *agency*, some *stimulus* to generate it; and as these peculiar *motions* occur in vessels which represent arteries, and as the tissue of arteries is both contractile and elastic, in varying degrees such rhythmic contractility will account for the pulsation in the *sacs*, whatever may be the nature of the *stimulus.*

Now what have we before us? The arteries, if I may so call them, pulsating at their connection with a fibre that runs off to the *brain*, from the two processes that support both the ciliated belt and the *pulsatile sac*, and what is most interesting to observe, is a perfect harmony between the rhythm of the *sac* and the beat of the cilia on the belt. It therefore appears that the pulsations do derive their influence from the brain, and further that, in the face of the accepted singular fact of ciliary *motion* being "entirely independent of a nervous system," it is also in this particular instance dependent on such a *stimulus*, either directly or through the agency of the coincident pulsations.

The connection of the antennæ with the vessels of the vascular system is clearly apparent: these organs were first considered by Ehrenberg, under the term "*calcar*," to subserve the generative process as intromittent organs. He subsequently corrected this notion, and promulgated the more reasonable one of their being "*respiratory tubes*," through which water might enter to act on the "*vibratile tags*." The correctness of this has been admitted by Siebold and others; but we read in Pritchard's *résumé* that subsequent researches "render such a conclusion untenable, and demonstrate their analogy with the antennæ of insects." Dr. Williamson mentions, in respect to *Melicerta*, the fact of the inversion of the tube "forming a double sheath protecting the setæ," and offers this, with the incident of their being the first parts that make their appearance on the animal emerging from its tube, in support of his deductions, but is

* 'Trans. Micro. Journal,' 1851.

compelled nevertheless to admit that "they are not directed in an exploratory manner from side to side," like the antennæ of insects. Dujardin states that "no trace of the entrance or exit of water is perceptible even when particles of colouring matter are diffused through the liquid calculated to indicate the slightest current;" and Perty, Gosse, Huxley, and Leydig coincide as to their non-perforated character.

Admitting at once the non-perforated character of these organs, the foregoing arguments offer themselves as corroborative evidence in proof of their being subservient to respiration. Now, the antennæ of the tube-building *Rotifera* are not only first exposed in emerging from the tubes, but they *always remain* exposed to the water, even during the animal's retreat. Once aware of their existence in *Floscularia coronetta*, this fact became most manifest; so that while other functions may be suspended, that of respiration, which is vital in the higher animals, is permitted to continue uninterrupted.

It is not necessary that these organs should be *perforated* to admit water from without, this, being of a different density to that which permeates the vessels of the body, would enter the tubes or tubercles by the process of *Endosmosis*. *Leydig* adopts this hypothesis, but hampers his conclusions with the assumed necessity for palpable orifices. *Endosmosis* operates through membranes such as even the blood-vessels of the slug having a layer of chalk; through the more delicate membranes of the capillaries; and with animals that exist in, and respire an element abounding in particles whose intrusion or contact would be detrimental, if not fatal to the due performance of the process, the general integument of the animal may be impervious to its action, while these protuberances may be specially constituted to promote it, under the protection from accident these accompanying bristles are eminently calculated to afford, so as to ensure the uninterrupted action of *Endosmosis*, whose gentle and constant operation of molecular intrusion would create no current sufficient to influence anything so gross as visible particles of colouring matter; while on the other hand the fluid thus induced and circulated by the agency of the pulsations, collects in, and after inflating the cloaca, is discharged by the intermittent action of *systole*, which *has been* observed in the case of *Notommata* to disturb the adjacent particles of floating matter by a palpable *jet d'eau*.

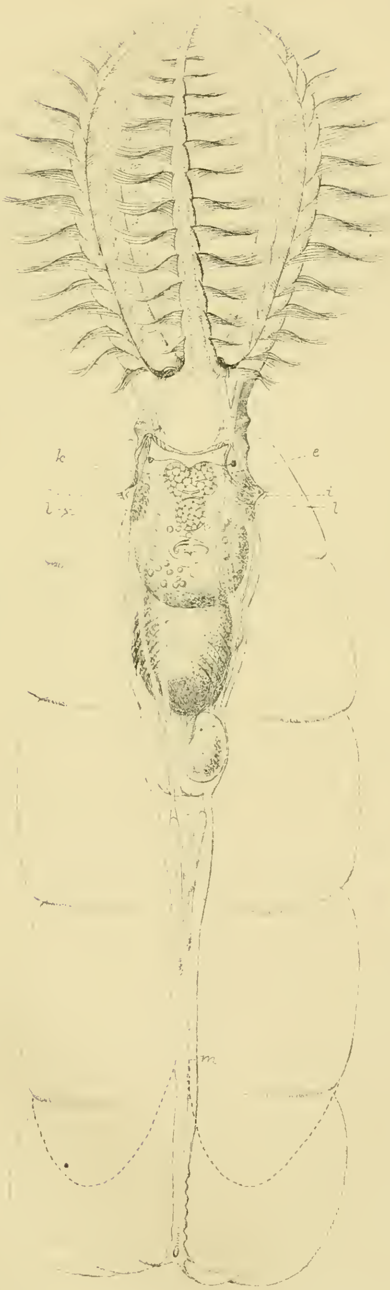
It would therefore appear that these processes involving *motions* must be of necessity dependent on some *force*; and seeing their intimate connection with the *brain*, we may safely assume them to be due to *nerve force*. The *brain* has been referred to as such, and also as a *ganglion*. It is seated in the anterior regions in a dorsal aspect; it is pear-shaped, constricted in the middle, where it supports certain small processes which traverse its substance as well as project beyond (Figs. 1, 2, *k*). In active individuals the brain is large and prominent, but less conspicuous in others whose sluggish movements indicate disease or age; its structure is not *granular*, except at its internal attachment, and is in no way related to the granular layers that occur on each side of it (Fig. 1, *l*, *l*). It presents more the appearance of a cellular structure, but differs essentially from the character of such structure, however much it may on first sight resemble certain vegetable cellulose, the divisions incline to a pentagonal arrangement, and each junction or union of the fibres is distinguished by a definite *nucleated* swelling, faintly resembling Gratiolet's figures of the nerve cells of the spinal cord (Plate LII., Fig. 8).

What the office of the projecting processes can be I am at a loss to surmise; its analogue occurs in *Floscularia coronetta* as a single projection, furnished with a knob at its extremity like a tentacle of *Coryne*.

In concluding these remarks I must briefly refer to a point in reference to the case. I find from numerous instances afforded me in detaching specimens from their support, that the case is not attached to such support *around* the foot, but to the foot itself; and under such conditions it shows with every retraction of the animal that the tube is so attached, by reason of its being inverted in the manner represented by the dotted lines (Plate LII., Fig. 1), assuming the foot to be withdrawn to a point (*m*), which would not happen without some connection with the foot, nor would the outer coating be so drawn in if the case were of the same consistency throughout, for then the retraction of the foot would induce an effect similar to that of "taking a dip" of Canada balsam; then, taking into account the appearance of the foot itself exhibiting a swelling containing a nucleated body (Fig. 9), which in all probability is a secerning gland for the secretion of the substance of the case, we may conclude that there is an organic connection between the animal and the case.

Beyond these minor considerations, we have seen from the foregoing remarks that, notwithstanding the great difference in external appearance, there exists a very close relationship between these higher and abnormal forms. The trochal disc of *Stephanoceros* and *Floscularia*, with their accessory processes, are truly the homologues of that of the higher forms with theirs; they perform precisely the same functions, and this second range of cilia exists, to my certain knowledge, in each of the following genera, viz. *Melicerta*, *Limnias*, *Tubicolaria*, *Œscistes*, *Lacinularia*, and *Conochilus*—in fact in each of the *Loricated* genera of Ehrenberg; we have seen that their respiratory system is parallel with, and that on the point of the constancy of the visual organs they are superior to the higher forms, unless future observation prove their constancy to exist in the whole Family; and we see, moreover, that the manducatory apparatus is of a much higher type than has hitherto been admitted; and when

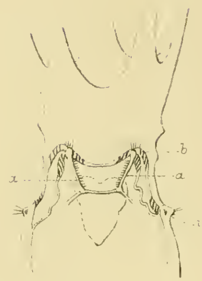
1



2

lateral aspect
slightly oblique.

3



Ventral aspect

10

Jaws × 250
after treatment with Potash.

4

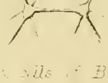
5 6 7

different appearances
of eye ball × 1000.

9

View of foot ×

8



nerve cells of Br...

C. Cubitt del. Tuffen West Sc.

W. West imp.

Stephanoceros × 100

Dorsal aspect

these relations are thus closely established, we cannot but feel, notwithstanding the disadvantage he laboured under in the possession of an inferior instrument, that Ehrenberg manifested more scientific and practical acumen in his arrangement of this Family than subsequent writers, who, fortified both with superior appliances and with the ground to work upon that he had previously cleared, have sought to upset this for modifications of their own, and that under less excusable conditions they are equally at fault with the great Professor whom they have twitted with the frequency of his mistakes in insisting on unimportant and inconstant particulars as generic and specific characteristics.

VI.—*Notes on Diatomaceæ.*

By Professor Arthur Mead Edwards.

My notes are of observations made by means of the microscope, and the first is relative to one of those curious atomies of the vegetable kingdom, the Diatomaceæ. Some time since I made a gathering in a ditch communicating with the salt water of the Hudson River, opposite the city of New York, at Weehawken, N. J. Of course the water in the ditch was salt, and, in fact, in it last spring I had caught specimens of Stickleback (*Gasterosteus*) which had come up there from the river to spawn, as is their wont to do. The Ten-spined Stickleback (*G. pungitius*) I had found very plentiful, and mixed with it a few individuals of the Three-spined (*G. aculeatus*); in fact these fish occurred in such numbers that when the water became foul, as it did by evaporation, the bottom of the ditch was literally covered with their dead bodies. The gathering, however, I have to speak of at the present time was made for the purpose of procuring Diatomaceæ, and consisted of specimens of an alga belonging to the genus *Enteromorpha*, having attached to it more or less firmly numerous Diatomaceæ and animals. The commonest form of diatom was a *Cyclotella*, and seemingly fixed in some manner to the *Enteromorpha*, for it was not shaken off by pretty rough usage. How it was fixed I could not detect; most likely by means of a mucous envelope of such tenuity that it is not readily seen.

The next most common form is the truly wonderful, inexplicable *Bacillaria paradoxa*, the paradoxical bundle of sticks. Often and often have I spent hours looking at this marvel of nature; the motion without apparent cause or mode, an invisible joint which, as a friend of mine, an engineer, once remarked, would be a fortune to any one who would discover it, for here we have several sticks forming the bundle, moving over each other without separating, and yet the use of the highest powers of the microscope has failed to detect the means of their union into one mass or composite group of individuals. This grouping of individuals together, which we so commonly find among the Diatomaceæ, as in *Schizonema*, *Achnanthes*, *Melosira*, and a host of other genera, appears to me to have its analogue in the animal kingdom in the Polyzoa; which, although generally fixed, yet at certain periods throw off motile forms by means of which the species is distributed. Do not the Diatomaceæ do likewise? I am of opinion that they do, and I shall produce evidence on that point farther on. As to the *Bacillaria paradoxa*, the oftener I watch it the more it puzzles me. Not long since I saw one specimen (of course I mean one bundle of individuals) slide out to its utmost limit across the field of view, and then, becoming entangled with two others, which likewise were made up of many individuals, some eight or ten of its frustules (as the complete individuals are called) were twisted around almost off from the rest, so as to lie at right angles to them, and when the group containing the largest number of frustules receded to their former position, which they soon did, the eight or ten seeming by the act of twisting to lose their power of motion among themselves for the time being, were dragged along in a helpless condition, and twisted completely around one revolution, so as thereafter to fall back again into their places, when all went on as usual. That is to say, the regular motion of all the frustules over each other succeeded. Now what kind of a joint can it be that permits of such eccentric movement! As I have already said, I am more puzzled than ever.

For some time back a discussion has been taking place in some of the European journals as to whether this plant be an inhabitant of fresh or brackish water. What I have observed points to the fact that it will live in either. I have collected it in brackish water at Hoboken, N. J.; my Weehawken collection was from a ditch connecting directly with the salt water of the Hudson River at its mouth, and some years since I gathered it in the sweet fresh water of the Fishkill creek, along with desmids and other truly fresh-water plants which, as far as we know, will not live in water containing any appreciable amount of salt, and then, also, in winter and under the ice, but nevertheless in an active condition. And I have taken my salt water Weehawken gathering and diluted it with several times its volume of fresh water, and yet it seems to flourish after many days, and the *Bacillaria* is apparently more active than when first procured.—*Paper read before the Boston Society of Natural History, February 9th.*

(To be continued in our next No.)

PROGRESS OF MICROSCOPICAL SCIENCE.

Italian Fossil Bryozoa.—At the meeting of the Vienna Academy, on the 10th of March, Dr. Reuss presented the fourth part of Dr. Manzoni's 'Italian Fossil Bryozoa.' It contains the description of twenty-four species of chilostomous bryozoa, of which two belong to each of the genera Salicornaria, Hippothoa, and Eschara; one to each of the genera Lepralia, Retepora, Lunulites, and Cupularia; six to the family Cellepora; and, lastly, eight to the Membranipora. Nine of them are quite new. The species described occurred partly in the Pliocene of Calabria and Castellarquato, partly in the Miocene of Turin, and other places. At the conclusion of the paper the author is led to notice three species of cyclostomous bryozoa, and through this to comment on the general zoological value of many genera founded only on the different arrangement of the tube-cells.

Staining Dental Tissues.—A recent number of the American 'Dental Cosmos' contains an interesting paper on this subject by Mr. J. S. Latimer, in which he gives the result of various experiments with Dr. Beale's carmine solution, and points out results which support Dr. Beale's theory of "germinal matter."

The Microscope in the Examination of Meteorites.—In a paper lately read before the Royal Society, Professor Maskelyne gave an account of his microscopic observations on the Busti Aërolite. Speaking of the presence of augite in the mineral, he says that associated with it throughout, and otherwise forming the chief mass of the stone, is a mineral which, in microscopic sections, presents the appearance of a number of more or less fissured crystals of varying transparency, some clear, some nearly opaque, and usually presenting a not very unsymmetrical polygonal outline. Those crystals are imbedded in a magma of fine-grained silicate, itself often entangled in an irregular meshwork of opaque white mineral. Amongst these ingredients, when mechanically separated, what seems to be three different minerals can be distinguished. The rarest of them is transparent and colourless, and very irregular in the form of its fragments; a second is of a greyish-white colour, translucent, and offering an even less hopeful problem to the crystallographer than that presented by the first. The third is an opaque mineral with a distinct cleavage following the faces of a prism of about $\frac{88 \cdot 35}{91 \cdot 27}$, and with a second imperfect cleavage perpendicular to the former. From a few fragments of the two former kinds some measurements were obtained, which conduct to the conclusion that, like the last-mentioned silicate, these minerals are enstatite.

The Development of Echini.—The 'Bulletin of the Museum of Zoology,' No. 9, contains an account of the results of the deep-sea dredgings between Cuba and Florida, and includes Mr. A. Agassiz's observations on the young stages of Echini made upon the collections of Count Pourtales. With these Mr. Agassiz has been able to study the young of thirty odd different species belonging to as many different genera. These observations are important and interesting. Among other points of interest, the author states that the changes some species undergo are so great that nothing would have been more natural than to place the two extremes of the series not only in different species, but often in different genera, and even in different families. The different stages of growth of *Toxopneustes drobachiensis* Ag., represent in the younger stages Cidaris, then Hemicidaris, then Pseudodiadema, Echinocidaris, and Heliocidaris. In Cidaris, Diadema, and Garelia, the changes are less marked, and in Echinometra they are greater than in any other genus of the regular Echini. "We frequently find," says the author, "specimens of the same size, where in one case the outline is almost circular, the test flattened, covered with long slender spines; while in the other the test is lobed, swollen, high, surmounted by numerous short stout spines. Among the Clypeastroids we find in the young during their growth great changes of form and structure taking place." The transformations of *Mellita testudinata* and *Encope emarginata* are described as identical, whilst those of *Mellita testudinata* and *Mellita hexapora* are not so much alike, although both of the same genus. "The development of *Stolonoclypus prostratus*, and flat Clypeastroids of the type of *Clypeaster placunarius* is most instructive, tending to show that in connection with the development of the Scutellidæ, we must probably introduce a complete reform among the genera recognized as Lemtia, Scutellina, Runa, Echinocyamus, and other minute Echinoids, which may eventually prove to be nothing but the young of other Clypeastroids, as Mellita, Scutella, Laganum, Stolonoclypus, Clypeaster, Encope, and the like; but want of sufficient material prevents me from entering into this comparison more in detail. Though we know now, from what has been said above, that the Scutellidæ pass through phases which cannot be distinguished from Moulinsia Fibularia, Runa, Scutellina, and the Clypeastroids proper pass, through a stage of growth identical with Echinocyamus. The development of Echinolampas has thrown unexpected light upon the affinities of the toothless Galerites and of the Cassidulidæ. It shows conclusively that Echinoneus is only a permanent embryonic stage of Echinolampas, thus becoming allied to the Cassidulidæ, and that it has nothing in common with the Galerites as I would limit them, confining them entirely to the group provided with teeth."

Structure of Fossil Fern-stems.—Mr. Carruthers, who continues his laborious researches on the subject of fossil plant-structure, recently read a paper before the Geological Society, "On the Structure of a Fern-stem from the Lower Eocene of Herne Bay," and showed the great value of the microscope in inquiries of that sort. He stated that the structure of the plant in question most closely agreed with the living *Osmunda regalis*, and certainly belonged to the Osmundaceæ. The broken petioles show a single crescentic vascular bundle. The section of the true stem shows a white parenchymatous medulla, a narrow vascular cylinder interrupted by long slender meshes from which the vascular bundles of the petioles spring, and a parenchymatous cortical layer. The author described the arrangement of these parts in detail, and indicated their agreement with the same parts in *Osmunda regalis*. He did not venture to refer the Fern, to which this stem had belonged, positively to the genus Osmunda, but preferred describing it as an Osmundites, under the name of *O. Dowkeri*. The specimen was silicified, and even the starch-grains contained in its cells, and the mycelium of a parasitic Fungus traversing some of them, were perfectly represented.

The Diagnostic Value of Blood-corpuscles in the Urine.—An important paper, illustrating the value of the microscope in its application to medicine, which was published some time since in the 'American Journal of Medical Science,' has been sent to us in reprint form by the author, and we commend it to the notice of our medical readers. The paper is one containing a great deal of original observation, and supplying a number of details not to be found in even the best treatises on Renal diseases.

Microscopic Crystals in Gems.—In connection with the excellent paper which Mr. Sorby some time since communicated to our columns, we would call attention to a very instructive memoir which, though it was read nearly twelve months since before the Philadelphia Academy of Natural Sciences, has only recently been published, and unfortunately too without figures, if we may judge from the proof-sheets which have reached us. In a previous paper the author describes his observations on Garnets. In this he remarks on the microscopic structure of Sapphire, Garnets, Labradorite, Black Felspar, Barite, Amethyst, and Ruby.

The Egg of Sacculinæ.—Those interested in this subject will be glad to know that M. Ed. Van Beneden has replied to the observations of M. Balbiani, which were some time since reprinted in these columns.

The Foraminifera obtained during Dr. Carpenter's last Expedition.—In contrast with the specimens obtained during the 'Lightning's' dredgings, Dr. Carpenter, in his recent lecture before the Royal Institution, says that the Foraminifera collected in the 'Porcupine' expedition present features of no less interest, though their scale is so much smaller. The enormous mass of Globigerina-mud (sometimes almost pure, sometimes mixed with sand) that everywhere covers the deep-sea bottom in the region explored, save where its temperature is reduced nearly to the freezing-point, may be judged of from the fact that in one instance the dredge brought up *half a ton* of it from a depth of 767 fathoms. The resemblance of this deposit to chalk is greatly strengthened by the recognition of several characteristically Cretaceous types among the Foraminifera scattered through the mass of Globigerinæ of which it is principally composed; as also of the Xanthidia, frequently preserved in flints. Not many absolute novelties presented themselves among the Foraminifera that form true calcareous *shells*; the chief point of interest being the occurrence of certain types of high organization at great depths, and their attainment of a size that is only paralleled in much warmer latitudes, or in the Tertiary or yet older formations. This is especially the case with the Cristellarian group, which has a long geological range, and also with the Milioline, of which specimens of unprecedented size presented themselves. The most interesting novelty was a beautiful Orbitolite, which, when complete, must have had the diameter of a sixpence, but which, from its extreme tenuity, always broke in the process of collection. Of Arenaceous Foraminifera, however, which construct *tests* by cementing together sand-grains, instead of producing shells, the number of new types is such as seriously to task our power of inventing appropriate generic names. Many of these types have a remarkable resemblance to forms previously known in the Chalk, the nature of which had not been recognized. Some of them throw an important light on the structure of two gigantic arenaceous types from the Upper Greensand, recently described by Dr. Carpenter and Mr. H. B. Brady, an account of which will appear in the forthcoming part of the 'Philosophical Transactions;' and there is one which can be certainly identified with a form lately discovered by Mr. H. B. Brady in a clay-bed of the Carboniferous Limestone.

NOTES AND MEMORANDA.

Nobert's Nineteenth Band.—With reference to the observation of this band, we beg to call the attention of our readers to two important letters on this subject which appear in our Correspondence. Doubtless our English microscopists will have much to say in reply, and we shall be glad to publish their answers in our next issue if possible.

The Spontaneous Generation Theory.—In connection with the somewhat fierce controversy on this subject which has taken place between Professor Tyndall and Dr. Bastian, the latter states some facts of interest. Dr. Bastian says that from his investigations he has come to the conclusion that organisms are to be met with in hermetically-sealed vessels from which all air has been removed, and after the contained fluids have been raised to a very high temperature. He and Dr. Frankland have placed solutions containing organic matter and other ingredients in flasks, exhausted the flasks of the air they contained, by means of Sprengel's pump, and then hermetically-sealed the drawn-out necks of the flasks in the blow-pipe flame. The airless flasks containing then the fluid itself, as the only possible germ-containing material, were submitted in a suitable apparatus by Professor Frankland to a temperature varying from 148° C. to 152° C. for four hours, and yet after having been placed under the influence of suitable conditions, in the course of a few weeks living organisms—many of them altogether new and strange—were found in these fluids. He abstains from mentioning all details as to the nature of the materials used, and many interesting facts observed by him in his experiments, as he hopes soon to lay a full account of his researches on the subject before the Royal Society.

A History of British Diatomaceæ, by Dr. Donkin, Lecturer on Forensic Medicine to the University of Durham, is preparing for publication by Mr. Van Voorst.

Fungi and Disease.—We observe with satisfaction that at the meeting of the American Medical Association, which will be held at Washington on the 3rd inst., among other papers will be one by Dr. Lemuel J. Deal, Pennsylvania, chairman, "On the Cryptogamic Origin of Disease, with Special Reference to Recent Microscopic Investigations on that Subject."

Recent Works on the Embryology of Articulates.—The 'American Naturalist' gives the following useful summary in its April number:—"Professor Claparède has published a paper, richly illustrated, 'On the Embryology of Worms,' especially Spirorbis, in Siebold and Kölliker's 'Journal.' Melnikow writes in 'Wiegmann's Archiv' 'On the early stages of *Tænia cucumerina*,' with a few figures. Dr. Richard Greef publishes in the same number of the 'Archiv' some most interesting researches on certain remarkable forms of Arthropoda and worm-types, illustrated by four plates. Dr. Anton Dohrn has lately published the first part of his 'Researches on the Structure and Development of Arthropoda' (Insects and Crustacea), with nine excellent plates. It is extracted from Siebold and Kölliker's 'Journal.' He here records his observations on the embryology of Cuma and allied genera, of certain sea spiders (Pycnogonidæ), and thinks that embryology shows that these curious animals, classified by many naturalists with the Arachnida, are really Crustacea; and of Daphnia, Praniza, and *Paranihura Costana*. A paper of the greatest interest to entomologists is M. Ganin's 'Contribution to a Knowledge of Developmental History in Insects' in Siebold and Kölliker's 'Journal.' It is fully illustrated."

Croydon Microscopic Club.—The Croydon Club owes its delivery so much to the skilful nursing of many of the leading Fellows of the Royal Microscopical Society, that the following account from the 'Lancet' of April 23rd will interest all our readers:—

"A large meeting has been held at Croydon for the purpose of organizing a body of gentlemen interested in the microscope and its revelations. The chair was occupied by H. Lee, Esq., who was supported by a number of *savants* well known for their proficiency in science. In his introductory remarks, Mr. Lee dwelt on the gratifying circumstance that the Club commenced with upwards of eighty members, including three Fellows of the Royal Society, four of the Linnæan Society, three of the Geological Society, and several of the Royal Microscopical Society, along with members of the Quekett Club. Mr. Lee, after illustrating the combined pleasure and profit to be gained from such pursuits as the Club proposed to itself, called on Dr. Bowerbank, F.R.S., to address the meeting. In the course of his remarks, Dr. Bowerbank referred to the time, now forty years ago, when there were but four achromatic microscopes in existence, one of which belonged to himself. Very early in his studies he saw, by means of Tully's microscope, the valves in the dorsal vessel of the *Ephemera* pumping the blood and sending it through the arteries; but, on publishing his discovery, its authenticity was questioned by no less a man than Geoffroy St. Hilaire. Dr. Bowerbank, however, succeeded in submitting an admirable specimen of the insect to that distinguished naturalist, who had hardly gazed at it five minutes through the microscope when he exclaimed, 'Ah!' and continued poring over the field, till at length, when the insect made a plunge and escaped, he threw up his arms with a loud 'Magnifique!' Such delightful surprises were quite within the reach of every microscopist who had access to any pond in the neighbourhood. The Rev. J. B. Reade then followed, and illustrated the advantages which the microscope might confer on every cultivator of the soil. By its teachings he had been enabled to grow Swedish turnips reaching 38 inches in diameter, one of which he scooped out, and after inserting in the cavity a hare, a pheasant, and a brace of partridges, and replacing the top, he sent the turnip to an agricultural friend. By his microscopical investigation of the soil, he had doubled the value of his living, which enabled him to sell for a good round sum twenty acres for the erection of an asylum, of which his friend Dr. Millar was the first physician. Mr. Reade next referred to the dung-heaps in farm-yards, which were intended as manure during the winter; but which on being turned over lost a great deal of muriate of ammonia by evaporation—a fact which he discovered by the microscope, after pouring on to a slip of glass a drop or two of muriatic acid, and applying it to the steam which was escaping from the manure. Great loss is sustained through this evaporation by the farmer, the quantity of wheat grown being in proportion to the quantity of ammonia in the manure. To prevent the escape of this most valuable nutrient agent, he poured upon his dung-heaps a large quantity of dilute sulphuric acid. The hints which the scientific cultivator of whatever class might obtain from the microscope are as remunerative as they are manifold—a conclusion which was still further enforced by the next speaker, Mr. Glaisher, F.R.S., and particularly by Mr. Frank Buckland, who described the advances made in pisciculture by the microscope, insomuch that opposition oysters might be grown to Mr. Reade's turnip, capable of holding not only one pheasant, but a brace of them, in addition to the other game mentioned by that gentleman! The arguments in favour of the Club and its objects derived yet fresh illustration from the President of the Croydon Farmers' Club, Mr. Fuller, who indicated the check that might be put to the ravages of insect life by microscopic research and its teachings. With much interesting discussion to the same effect, the Croydon Microscopic Club closed its first and highly auspicious meeting."

CORRESPONDENCE.

The Resolution of Nobert's Nineteenth Band.

To the Editor of the 'Monthly Microscopical Journal.'

Boston, Massachusetts, U.S.A.,
March 31, 1870.

Sir,—In the Journal for February last, p. 104, you have a note from Mr. Lobb, in which he refers to a discussion on Dr. Woodward's paper (in the December No.), in which discussion Mr. Lobb "expressed a doubt whether the lines on Nobert's test-plate could be clearly defined beyond the 16th group." I trust that I may be able to remove Mr. Lobb's doubt; though he was, I think, justified in expressing such doubt, if he had had no other evidence of the fact than the photographs of Dr. Curtis.

On the other side, in the March No. of your Journal you publish the Address of the President of the Royal Microscopical Society. In this address the following passage occurs: "It is proper to remark that Colonel Woodward has resolved the 19th band of Nobert's lines with a Powell and Lealand $\frac{1}{16}$th immersion. He is the only observer who has succeeded in resolving 112,688 lines to the inch with a power of 1000 linear."* In this passage the President, unlike Mr. Lobb, expresses no doubt; but asserts, as of his own knowledge, not only that the lines were resolved, but goes farther, with another assertion that he, Dr. Woodward, is the only observer who has succeeded with that amplification. For all this the President relies on Dr. Woodward's own assertions and claims. Yet in the 'Quarterly Journal of Microscopical Science' for July, 1868, copied from the 'American Naturalist' of April, 1868, was printed a communication from me, stating that Mr. R. C. Greenleaf and myself had, in the autumn of 1867, both seen the lines of the 19th band, with a Tolles' immersion $\frac{1}{6}$th objective, power 550. Also, that Dr. F. A. P. Barnard, President of Columbia College, N.Y., had seen and counted the same lines in January, 1848. Dr. Barnard informed me a few months ago, that he was satisfied that he did see the true lines at that time, and that he then believed that Nachet of Paris had also seen them. Why should the President ignore that paper, and admit, unqualifiedly, Dr. W.'s two years' later claim? He surely cannot say that he did not read my paper; if he did read it, then he was in fairness bound to at least state the fact, even if he could give no reason for adopting Dr. W.'s and rejecting Dr. Barnard's and my claim.

With your permission I will offer some statements that may relieve Mr. Lobb's doubt, and show the unsoundness of Dr. W.'s claims, as adopted by the President.

Mr. Greenleaf and myself both believe that we saw the lines of the 19th band in the autumn of 1867, with the first immersion objective

* Does the President know of anyone that has succeeded in doing it with any power other than those named in this letter.

made by Tolles, as described in my paper, before referred to. We were both familiar with the appearance of the lines (and of the "spectral" lines), having worked on them a great deal, and being conversant with all that had been published by others. Unfortunately that objective was broken before other experts had seen its performance. Mr. Tolles subsequently, in the winter and spring of 1868, made other immersion objectives, and put immersion "fronts" to "dry" objectives of his own and of A. Ross's make. One, a $\frac{1}{6}$th, was made in June, 1868, for Herr Th. Eulenstein, of Dresden. This, I think, resolved the lines in Mr. Tolles' hands; but of this instrument more anon. Another one, originally a $\frac{1}{8}$th of Tolles' make, had an immersion front in July, 1868. This showed the lines of the 19th band unmistakably, clear and well defined. The performance was seen by the owner, by Mr. E. Micknell of Salem, by myself, and perhaps some others. This was nine months before the Powell and Lealand sixteenth was made. After this other objectives were made by Tolles, which did the same thing.

In the spring of 1869, Dr. W. received his Powell and Lealand $\frac{1}{16}$th, and then for the first time he resolved the lines of the 19th band. I will not doubt but he *saw* the lines; but the photographs do not show them as I have seen them. In May, 1869, I sent to Dr. Woodward the $\frac{1}{10}$th immersion objective, which he refers to in his paper in the 'American Journal of Science' of September, 1869, and in the communication to this Journal, in December, 1869, which objective he calls a $\frac{1}{8}$th, and in a letter to me states that it is *only about one-half the power* * of the Powell and Lealand $\frac{1}{16}$th. With this *he* saw the lines of the 16th band; a feat that had not then been certainly accomplished in Europe with any instrument that I have any account of.

This objective was returned to me, and was put into the Exhibition of Massachusetts Charitable Mechanic Association in September. A competent board of experts were selected to examine instruments. In their presence, and in the presence of Dr. B. A. Gould and Professor W. Gibbs, of Harvard College, the lines of the 19th band were clearly and plainly resolved with that same objective. Two of the gentlemen who witnessed this had also seen Dr. W.'s resolution with the Powell and Lealand, and had no compunctions in saying that the $\frac{1}{10}$th did as well, if not better, than the $\frac{1}{16}$th, with all the elaborate aids used at the United States Army Museum.

Let me hope that this detail of facts in chronological order, will settle all questions of priority, both of observers and makers. If Mr. Lobb has any doubts remaining, if he will just step over to this side of the Atlantic, I shall be happy to show him the lines finer than the 16th band "clearly defined" with a $\frac{1}{10}$th.

I have referred to a $\frac{1}{6}$th made for Herr Eulenstein in June, 1868. He has expressed great approbation of this instrument whenever he has referred to it; but in the last month, February 11th, he writes to me from Dresden as follows: "I have sent the $\frac{1}{6}$th to Nobert. We

* It has since been measured by two experts independent of each other and of the maker; one made it a large $\frac{1}{9}$th, the other a $\frac{1}{10}$th, consequently the Powell and Lealand is either a $\frac{1}{18}$th or $\frac{1}{20}$th.

have both seen the lines of the 17th band [over 101,000] with it; no more at present; but this is an extraordinary feat for a $\frac{1}{6}$th, and is more than any other objective of that power that I know of can possibly be stretched to do."

Messrs. Nobert and Eulenstein both saw the lines of the 17th band with Powell and Lealand's $\frac{1}{16}$th immersion, but curiously enough they think they got the best effect with both objectives dry! I am convinced that the $\frac{1}{6}$th will do best wet, and therefore that they did not accomplish all that they might have done with it, but that by perseverance they could have resolved the 19th band.

As only two years previously Nobert had never seen the lines of his test-plate finer than the 14th band, and then doubted the visibility of any finer lines, his having now seen the 17th band with the Tolles' $\frac{1}{6}$th is conclusive evidence of the merits of the instrument, and may relieve Mr. Lobb's doubts, and Dr. Woodward's disbelief as to what had been seen.

On the value of Nobert's lines as a test, the President says, "the visibility of the lines is a function of the breadth of the groove ploughed in the glass,—the depth to which it is cut,—the section of the groove itself,—and the direction and character of the illumination employed,—all these variable conditions in some measure detract from the fixed value of this test."

Of course they do; and the same variable conditions affect all natural objects in the same manner, and in the case of the Diatomaceæ in a much greater degree. I do not know what Mr. Powell calls "Acus" (there is no such genus in Pritchard), or what he has to prove that it is a "sharper and safer test;" but I can say confidently (and other observers confirm me), after years of work on the diatoms, and on the test-plates, no less than four of them, that the plates are more uniform, more reliable, and hence "safer" than any diatom I have yet seen, for testing different instruments, in different places. It needs no argument to show that if all observers could use the same one object, whether natural or artificial, that such is the only absolute test. That being of course impossible, I contend that the "test-plates" of Nobert are more uniform, more reliable, and "safer" for comparison, than any other object yet known to microscopists.

Charles Stodder.

To the Editor of the 'Monthly Microscopical Journal.'

Boston, U.S.A., *April* 5, 1870.

Dear Sir,—I have read Mr. Stodder's very full and clear paper, which will be forwarded by this mail for publication in your Journal, on the subject of resolving the 19th band of the Nobert test-plate, and fully agree with his statements, which, as nearly as I can remember, are correct in detail and dates.

I have not kept the close run of this discussion that Mr. Stodder has, although personally interested, and was not present at the trial of objectives before the Committee of the Mechanics' Association, but at a meeting of the "Section of Microscopy" of the Boston Natural

History Society, soon after the award was made, two of the members of that Committee stated the facts, as Mr. Stodder has reported in his communication to you in regard to the resolving of the 19th band by the $\frac{1}{10}$th objective made by R. B. Tolles.

It is no easy matter to resolve their infinitely fine lines. No one, unless he has educated his eye and hand to this intensely fine work, can bring about all the delicate arrangements of light and adjustments of objective absolutely requisite to the performance of seeing the $\frac{1}{112000}$ths of an inch.

Not long since I endeavoured to show to a gentleman, considered an expert in microscopy, the lines in the 14th band by Tolles' $\frac{1}{7}$th immersion. It was with difficulty he could see the band, and failed of seeing the lines composing it, when to my eye they were as clearly defined as the ruled lines on a sheet of music paper; he therefore stated "that the lines had not been resolved!"

My friend Mr. Stodder and I have given much time to this work upon naturally and artificially lined objects, and with objectives of almost every maker, and think we know when we see true and when spectral lines.

I do not personally wish for any credit to be given me as an observer; but I do greatly care for the honour of our American optical instruments.

Most respectfully yours,

R. C. Greenleaf.

PROCEEDINGS OF SOCIETIES.*

Royal Microscopical Society.

King's College, *April* 13, 1870.

Rev. J. B. Reade, M.A., F.R.S., President, in the chair.

The minutes of the last meeting were read and confirmed.

A list of donations which had been received was also read, and a vote of thanks passed to the respective donors.

It was announced that the question as to the best day for holding the meetings of the Society had been brought before the Council. Many Fellows of this Society were also Fellows of the Geological, which held its meeting on the same evening; they were thus unavoidably absent from the one or the other. Moreover, as the second Wednesday in the month often fell late, it was attended with much inconvenience to the Editor of the Journal. The Council therefore suggested that the

* Secretaries of Societies will greatly oblige us by writing their reports legibly —especially by printing the technical terms thus: H y d r a—and by "underlining" words, such as specific names, which must be printed in italics. They will thus secure accuracy and enhance the value of their proceedings.—Ed. M. M. J.

day of meeting should be altered from the second to the first Wednesday in each month, and in accordance with this suggestion, notice was given of a motion at the next meeting of the Society, that the 20th bye-law should be so amended as to enable the Council to carry out the alteration.

Mr. Slack said that in consequence of the want of time at the previous meeting, there had been no proper discussion of the papers by Mr. Barrett "On a New Stentor" and Dr. Pigott "On High-Power Definition." He thought it undesirable that Mr. Barrett's paper should pass without some protest being made against the creature he had described being called a *Stentor*. The animal was undoubtedly an interesting object, but the description given of it did not justify the appellation bestowed upon it. Mr. Barrett says, "There were no cilia over the body; but standing at right angles to the body, and at equal distances from each other, there were long fine hairs." *Stentors*, according to the best authorities on the subject, had two kinds of cilia on their bodies. *Stein*, in his arrangement of Infusoria, divides the ciliata into Holotrichia, cilia of one character, and Heterotrichia, cilia of different characters. Stentors belonged to the latter, having small cilia thickly covering the body; and larger cilia forming an oral wreath. A creature which had no cilia on its body was a wide departure from the Stentors recognized by all the authorities. True Stentors had also characteristic body stripes, but Mr. Barrett's animal had no stripes. Mr. Barrett mentioned indications in his creature of a nervous system said to be similar to the Polyzoa; this would indicate a much higher rank than a Stentor, at least as high as a Rotifer. With reference to bristles on Stentors, so conspicuous in Mr. Barrett's figure, Stein speaks of objects of this description in true Stentors, which were protruded from the sarcode and disappeared, leaving no special mark of their entrance and exit. He supposed them organs of touch.

Mr. T. Charters White said it might be interesting to the Fellows to know that at the recent excursion of the Quekett Club to Wandsworth Common, he had found large numbers of an animal similar to the new Stentor described by Mr. Barrett, but inhabiting a transparent case. The longitudinal bands of cilia usually seen in Stentor were absent, and it had not the projecting bristles as figured in Mr. Barrett's drawing. The oral disc was of the shape of the human ear, surrounded by well-marked cilia. The body was granular, but with distinctly-defined vacuoles filled with Desmids. It was found abundantly on *Ranunculus aquatilis*, together with very large specimens of Stephanoceros.

Mr. Hogg explained that the case of Mr. Barrett's Stentor had been rendered opaque by the use of carmine. He had generally found the case of Stentor transparent, and believed that Stentors vary in appearance at different periods of the year. He had seen Stentors without striations through the sarcode body; but did not, however, regard the animal described by Mr. Barrett as a Stentor. From some observations he (Mr. Hogg) had made of Stentors, he had observed a process resembling conjugation in some of the Desmids, in which condition one animal was seen occupying the case of the other; drawings of this supposed sexual process was exhibited to the Society, and Mr. Hogg suggested the value of a systematic and careful examination of these animals throughout the year, and during their various stages of development, which might possibly show many departures from the common type.

Mr. Slack then read a paper by Mr. H. C. Sorby "On Colouring Matter derived from the Decomposition of Minute Organisms."

The President said that Mr. Sorby had sent him two letters last year on the subject of his present paper, and had promised a fuller account of his experiments in a future communication to the Society. This interesting communication had just been read. The specimens of the *dichroic fluid* forwarded some little time ago by Mr. Sheppard gave two essentially different spectra dependent on the presence or absence of albumen, and hence Mr. Sorby was led to conclude that the first *dichroic fluid*, which had given the same remarkable spectrum both to Mr. Browning and himself, was in point of fact a mixture of the albuminous and non-albuminous fluids. He (the President) had been able to report that such was the case. It would be in the recollection of the Fellows that Mr. Sheppard had given us an account of his own early experiments, and that Mr. Ray Lankester had made some rather stringent criticisms upon it, inasmuch as he had stated that Mr. Sheppard had gone out of his way to conjure up a mystery quite unnecessarily. Now, though he (the President) had a great respect for Mr. Ray Lankester's zeal, and valued the results of his microscopical investigations, he could not but think that in this instance his zeal had been allowed to outrun his discretion. It did really appear, as was acknowledged by Dr. Cohn in a letter to Mr. Sheppard, that Mr. Sheppard had produced a new *dichroic* fluid, new to English microscopists, and new to Mr. Sorby. The natural colour, which has a spectrum of its own, was probably due to the small amount of albumen naturally present in the confervoid mass, but Mr. Sheppard's artificial addition of albumen produced a new fluid characterized by a new spectrum; and Mr. Sorby, speaking of the chemical effects of reagents on this colour, says in his note of June 12, 1869, "Neither ammonia, citric acid, or sulphate of soda produce any change. It is a colour entirely new to me." The President observed, in conclusion, that the whole series of experiments was very interesting, as showing the accuracy of spectroscopic work and the dependence to be placed on first-rate observers.

Mr. T. Charters White said that about a fortnight ago a friend of his had brought up a bottle of *dichroic* fluid, which he had collected at St. Leonard's and sent to Mr. Sorby for his inspection, and he affirms that it is identical under spectroscopic examination with that found by Mr. Sheppard. It was observed in a stream in which there was a considerable ferruginous deposit. With reference to the changes of colour produced by the presence of albumen, he would remark that a very peculiar action takes place between vegetable substances and albumen, and it was a point to which he should like to see Mr. Sorby's attention directed.

Mr. Hogg said it occurred to him that it would be a very useful and accurate test of the presence of albumen either in vegetable or animal infusions. We want to know what substance, in conjunction with the albumen, tends to impart this remarkable colour in these *dichroic* fluids. It would be of great value in medical investigations if it could be determined by the spectroscope, whether in any particular fluid, say urine, albumen was present or not.

Mr. Slack thought that as Dr. Pigott's paper contained some points of great interest, and that gentleman was not present to join in the discussion, it would be better to defer the discussion for the present.

Mr. Slack called the attention of the meeting to a series of microscopic objectives made by Herr Gundlach, of Berlin, whose agent in England was Mr. Winspear, of Hull). The Gundlach objectives were remarkable for combining a very considerable amount of merit with unusually low price. The lower powers, 2-inch, 1-inch, $1\frac{1}{2}$-inch, were sold by Mr. Winspear at 17*s.*, and $\frac{1}{12}$th and $\frac{1}{16}$th immersion lenses at 3*l.* 12*s.* 6*d.*, including the Society's standard screw and brass boxes. Mr. Slack said that in comparing the prices of competitors with those of the great English makers it would be necessary to ascertain how far the former were careful in maintaining that uniformity of quality by which the best English glasses were characterized. It must also be remembered that extraordinary skill was required to excel beyond a certain point. He was not able to state the exact limits of the performance of Gundlach's $\frac{1}{12}$th and $\frac{1}{16}$th immersion lenses, but they well deserved attention. A good form of student's microscope with rotating stage by Mr. Winspear, and Gundlach's objectives was likewise exhibited.

Mr. Hogg then read a paper "On Cercariæ infesting Lymnæus Stagnalis."

Mr. Lee said he would mention a fact in confirmation of what had fallen from Mr. Hogg, respecting the prevalent opinion that parasites are universally a condition of disease. He had examined a great many fishes on which parasites were found, and had found that generally these fish were in the best of health. A nobleman of his acquaintance had recently told him of his experience in his fishing expeditions in Ireland. He had caught several fine salmon, but as some of them had parasites attached to them, his attendant, labouring under the popular delusion, had thrown them back into the water, and reserved only a few miserable fish on which parasites did not happen to be present; and he (Mr. Lee) took the opportunity of removing the erroneous impression from the mind of his friend. This fact with respect to parasites, he must mention, had relation to external parasites only.

Mr. Slack quoted the opinion of the distinguished naturalist, Van Beneden, in reference to parasitism. The term parasite, he (Van Beneden) says, can only be used when the creature lives upon and is really detrimental to the animal to which it is attached; and unless this evident mischief results from their contact, the term parasite cannot be properly applied. Mr. Slack then adduced some instances of animals (such as the Medusæ and Soldier Crab) which possessed what were usually called parasites, but which did not appear to suffer in the least from the animal they carried; on the contrary, they lived harmoniously together, and even appeared to consult each other's convenience.

The President moved a vote of thanks to Mr. Sorby and Mr. Hogg for their papers; and announced that he had received a paper from Dr. Bowerbank, containing some of his early reminiscences of the microscope. It was impossible that it should be read that evening; but as he had no doubt that it would be regarded with much interest by the Fellows, he would give a month's notice that it would be read at the next meeting of the Society.

The President then mentioned the fact that a Microscopical Club (an offshoot of our parent Society) had been most successfully inaugurated at Croydon. The club consisted of nearly a hundred members, and they had unanimously elected Mr. Henry Lee as their president.

The President then made some announcements with regard to the arrangements for the soirée, and the meeting was adjourned until the 11th May.

Donations to the Library from March 9th to April 13th, 1870:—

	From
Land and Water. Weekly	*Editor.*
Society of Arts Journal. Weekly	*Society.*
Nature. Weekly	*Editor.*
Scientific Opinion. Part XVII.	*Editor.*
Bed of the Atlantic. By Wm. Chimmo	*J. Glaisher, F.R.S.*
Popular Science Review. No. 35	*Editor.*
Journal of the Quekett Club	*Club.*
The Student. No. 2. New Series	*Publisher.*
The Terraces of Norway. By Professor Kjerulf. Translated by Marshall Hall	*Marshall Hall, Esq.*
Le Globe.	
Withering's Arrangement of British Plants. *3rd Edition.* 4 vols...	*A Friend, through W. W. Reeves.*
Francisci Redi's Experimenta circa generationem Insectorum. 2 vols. 1685.	*Ditto.*

The following gentlemen were elected Fellows of the Society:—

Thomas Sanders Crossley, Esq.
Frank Crisp, Esq.
Thomas Greenish, Esq.
John Anthony, M.D., Cantab., M.B., M.R.C.P., &c.

WALTER W. REEVES,
Assist. Secretary.

Annual Soirée of the Royal Microscopical Society.

The annual soirée of the Royal Microscopical Society was held at King's College, by the kind permission of the authorities of that Institution, on the 20th April, and was very numerously attended by Fellows and invited guests.

Tables round the great hall and down the centre were occupied with a special collection of 100 microscopic objects, selected to illustrate the invertebrate sub-kingdom, by Charles Stewart, Esq., F.L.S., member of the council of the R.M.S., who prepared a descriptive catalogue, a copy of which was sent to each Fellow some time previous to the soirée, accompanied by an explanatory letter inviting co-operation. Many Fellows of the Society lent microscopes and objects, and many other gentlemen kindly assisted; but a large portion of the objects, including many of rarity and beauty, were supplied by Mr. Stewart. The list comprehended characteristic specimens of Rhizopoda, Spongiadæ, Hydrozoa, Actinozoa, Scolecida, Echinodermata, Annelida, Crustacea, Arachnida, Myriapoda, Insecta, Polyzoa, Brachiopoda, Ascidioida, Lamellibranchiata, Gasteropoda, and Cephalopoda. The interest of this collection was much enhanced by a series of drawings illustrating the various orders and families of the objects exhibited, lent for the occasion by Prof. Rymer Jones, F.R.S., and Mr. Mummery, and arranged by Mr. Stewart.

A special department was occupied by Dr. Carpenter with a remarkably interesting collection—of which he contributed a descriptive catalogue—illustrating his Deep-Sea Dredgings. The first series contained Arenaceous Foraminifera, "to which the additions made by Deep-Sea Dredgings have been most remarkable." In these, "the shells of other Foraminifera are replaced by *tests*, which are *built up* by the animals constructing them from the materials furnished by the sea-bottom whereon they live; particular kinds of materials being selected and cemented together, so as to make particular forms of tests, with the most marvellous regularity and exactness. It is very curious to note that one and the same dredging will often yield a great number of types of these Arenaceous Foraminifera, differing not merely in the form, but in the *materials* of their tests, and also in their *mode of aggregation;* thus showing a selecting and constructive power in creatures which may be said to be mere particles of animated jelly (sarcode or protoplasm), possessing no 'organs' save the soft filaments into which this jelly extends itself."* Dr. Carpenter observes that "the most rudimentary forms of this series consist of spherical masses of Protoplasm, throughout which sand-grains are uniformly diffused, without any distinction of the containing wall and internal cavity. The next stage is presented in *Astrorhiza*, in which type there is a containing wall composed of sand-grains loosely aggregated together, surrounding a cavity occupied by sarcode; but there is no *distinct mouth*, the filamentous extensions of the sarcode-body probably finding their way out between the sand-grains, especially at the ends of the finger-like projections."

In the long tubes of the *Botellina* (from *botellum*, a sausage or pig's pudding) "an advance is shown. The wall of the cylinder is composed of sand-grains firmly cemented together; while its cavity is traversed by extensions of the like structure, intermingled with sponge-spicules, forming a rude labyrinthic arrangement."

* 'Descriptive Catalogue of Objects from the Deep-Sea Dredgings,' exhibited at the Soirée of the Royal Microscopical Society, King's College, 20th April, 1870. By Dr. Carpenter, F.R.S., &c.

In *Saccamina* "the test is of very regular spherical form, with a flask-shaped neck, and it is composed of large sand-grains firmly cemented together so as to present a smooth exterior, whilst their angles project into the interior of the cavity, which is filled with living sarcode." In *Pilulina* the form of the test is spherical, but it differs from *Saccamina* in its mouth being "a somewhat sinuous flexure," and being composed of extremely fine white sand-grains, worked up with the pointed ends of sponge-spicules. The specimens of this type shown by Dr. Carpenter "were brought up alive from 1215 fathoms." "The test of *Rhabdammina* is usually triradiate, having a central cavity which extends itself to the open end of each of the radiating tubes; and it is composed of quartz sand-grains, firmly united together by a cement which contains a large proportion of phosphate of iron."

The *Proteonina* present a very curious difference in their materials, which seems to depend upon the character of the bottom from which they were respectively obtained. Where this consists of nearly pure globigerina, and having sponge-spicules dispersed through it, but scarcely any admixture of sand, the animal builds up its test of sponge-spicules, only using a grain of sand here and there to fill up a corner left by the crossing of the sponge-spicules. But where the bottom abounds in sand-grains, the animal uses them as the materials of its test, still, however, using sponge-spicules for the prolongation which forms the mouth at each end, this prolongation being sometimes extended like a proboscis: found at a depth of 650 and 540 fathoms.

Concerning the Porcellanous Foraminifera of the Deep-Sea Dredgings, Dr. Carpenter remarks that "the *Miliolinæ* brought up from great depths are remarkable for their great size; no larger specimens of *Cornuspira*, *Biloculina*, and *Triloculina* being known than those here exhibited."

Fragmentary specimens of *Orbitolites* seemed to indicate that the entire disk must often attain the size of a sixpence. "The nucleus of this disk is formed by a spire of several turns, precisely resembling the central part of a *Cornuspira*: by the opening out of the spire, and the subdivision of its cavity into chamberlets, the first approach is made to the cyclical arrangement characteristic of the Orbitolite; and the whole subsequent growth takes place on the cyclical plan. Each ring contains an annular gallery, communicating with every one of the chamberlets; the outer side of this gallery gives off passages which lead into the chamberlets of the next ring; and the passages thus given off from the marginal ring open as pores on the surface, and constitute the only channel of communication between the entire system of galleries and chamberlets to the exterior."

Dr. Carpenter observes of the Vitreous Foraminifera that the "*Globigerinæ* and *Orbulinæ*, of which an accumulation covers a large proportion of the North Atlantic sea-bed to an unknown thickness, formed a deposit closely resembling chalk. These types occur at all depths, from 200 or 300 fathoms to *three miles*."

In addition to the above, Dr. Carpenter exhibited a series of *Cristellariæ*, showing every gradation from the straight to the nautiloid form; also the animal of *Cristellaria*, obtained by dissolving the shell of a fresh specimen in dilute acid; and also slides of *Nodosarinæ* and a small *Lingulina*.

The siliceous skeleton of a polycystine form of Radiolaria of frequent occurrence at considerable depths, was shown in Dr. Carpenter's collection; and a slide of Radiolariæ taken alive on the surface of the sea in the neighbourhood of Shetland, where they float in masses, mingled with *Entomostraca*, which are known to the fishermen as "*madre*," and are said to furnish food to the herring shoals.

A slide of the siliceous skeleton of *Aphrocallistes Bocageii*, "first discovered by Dr. Perceval Wright off the coast of Cornwall, and since found at great depths at the mouth of the Bristol Channel, was shown; and likewise the interesting crinoid, *Rhizocrinus lofotensis*, first discovered by Professor Sars, at a depth of about 300 fathoms, near the Loffoden Islands; and since met with in the 'Lightning' and 'Porcupine' Expeditions, at various depths down to 2000 fathoms; found also in the Gulf of Mexico. This crinoid belongs to the Apiocrinites, of which the pear-shaped fossil of the Bradford clay is a characteristic representative."

The Deep-Sea annelids were represented by tubes; "some built up of Globigerinæ; others of cemented sand-grains; while others have a coloured internal layer of animal substance, which acts as a foil to the sand-grains that are attached to its outer surface."

Dr. Carpenter brought a beautiful series of drawings, illustrating the objects displayed, and others that were found in the Deep-Sea Dredgings. Mr. Henry Lee made the arrangements and assisted Dr. Carpenter in this part of the exhibition.

New Instruments, Objectives, &c.—Messrs. Powell and Lealand exhibited a $\frac{1}{8}$th and $\frac{1}{16}$th objective on the immersion principle, both worked upon new curves. The former was shown in action upon the test Podura scale (*Lepidocyrtus curvicollis*); and the latter upon the *Navicula rhomboides*. These new lenses differ somewhat in the character of their definition from those previously used by the same firm. They are more perfectly achromatic, not only without sacrificing, but with an addition to sharpness of definition, and give a brilliant field without the glare so common in immersion objectives. These objectives are furnished with fronts for dry use.

Messrs. R. and J. Beck exhibited an immersion $\frac{1}{8}$th, showing the Podura markings very distinctly, characterized by the well-known appearances in the drawings of the late Richard Beck, and which microscopists have accepted as tests.

Mr. Crouch exhibited an immersion $\frac{1}{8}$th, working well upon *P. angulatum*, and belonging to his new series of objectives.

The most decided novelty was shown by Mr. Holmes, who exhibited four binocular microscopes, each differing in mechanical arrangements; but all upon a hitherto untried optical principle of dividing the objective by vertical section into two equal and corresponding halves. The powers employed were one inch. Each tube of the binocular was equally illuminated, and the definition sharp. These instruments will be brought before the notice of the Society at its next meeting.

Mr. Baker showed a microscope with a new and convenient horizontal stage-movement, worked by an eccentric disk conveniently situated to be acted upon by the finger.

Mr. Moginie exhibited a very handy and complete portable travelling microscope. A pocket microscope was also shown by Mr. Browning, and by Messrs. Murray and Heath.

Mr. Crouch exhibited a new microscope devised by Mr. Fiddian, one peculiarity of which consists in the coarse adjustment being formed by the movable bar being cut with a screw-thread, and worked by a large milled head with a counter-screw. On Mr. Crouch's table there was likewise a modification of Fiddian's lamp, with a chimney of white opal glass, having a central opening to receive a disk of white glass.

Mr. Swift exhibited a Bockett lamp with a cylindrical porcelain shade.

Mr. Ross, Messrs. R. and J. Beck, Mr. Ladd, Mr. Browning, Messrs. Murray and Heath, Messrs. Gould and Porter, Messrs. Horne and Thornthwaite, Stanley, Swift, Wheeler, Dancer, Winspear, and Bailey, contributed very numerous objects of interest.

Mr. Norman showed a superb collection of sections of fossiliferous coal, made with unusual skill.

In an upper room a large table was occupied with students' instruments by various makers, to which prices were affixed ranging from 10*l*. downwards.

In the course of the evening Mr. Browning gave illustrations of spectroscopic phenomena, including recent astronomical researches; and Mr. How displayed with a gas microscope a series of natural objects, micro-photographs, &c.

Quekett Microscopical Club.*

At the ordinary meeting held at University College, March 25th, 1870, P. Le Neve Foster, Esq., M.A., President, in the chair, four new members were elected, and a number of presents to the library and cabinet were announced. Mr. M. C. Cooke read a paper upon "Microscopic Moulds," illustrating the subject by a large number of diagrams and by specimens exhibited under the microscope at the close of the meeting, and a quantity of specimens of several species were placed upon the table for distribution amongst the members. Mr. Edward Richards exhibited and described his new method of using Darker's selenite films. The President, in reference to the recent soirée, announced that the proceeds of the sale of extra tickets, amounting to 5*l*. 7*s*. 6*d*., had been voted by the committee to the funds of University College Hospital; and votes of thanks to those members who exhibited objects at the soirée were carried unanimously. The President also announced that the fortnightly field excursions of the Club would be resumed in April. Nine gentlemen were proposed for membership, and the proceedings terminated with a conversazione, at which a number of objects of interest were exhibited.

* Report supplied by Mr. R. T. Lewis.

Literary and Philosophical Society of Manchester.

Ordinary meeting, February 22nd, 1870. J. P. Joule, D.C.L., LL.D., F.R.S., &c., President, in the chair.—The only paper of microscopical interest was the following: "On the Organic Matter of Human Breath in Health and Disease," by Dr. Arthur Ransome, M.A. The author having given an account of the chemical constitution, then considered the question of the presence of spores.

Mr. Dancer's calculation of the number of spores contained in the air was noticed, but a source of error was pointed out in the readiness with which organisms are developed in suitable fluids, even in the course of a few hours. Observations upon the organic particles of respired air had at different times been made by the author.

1. In 1857 glass plates covered with glycerine had been exposed in different places and examined microscopically. Amongst others, in the dome of the Borough Gaol, to which all the respired air in the building is conducted: organized particles from the lungs and various fibres were found in this air.

2. During a crowded meeting at the Free Trade Hall, air from one of the boxes was drawn for two hours through distilled water, and the sediment examined after thirty-six hours. The following objects were noted:—fibres, separate cellules, nucleated cells, surrounded by granular matter, numerous epithelial scales from the lungs and skin.

3. The dust from the top of one of the pillars was also examined, and in addition to other objects, the same epithelial scales were detected.

4. Several of the specimens of fluid from the lungs were also searched with the microscope. In all of them epithelium in different stages of deterioration was abundantly present, but very few spores were found in any fresh specimen. On the other hand, after the fluid had been kept for a few hours, myriads of vibriones and many spores were found.

In a case of diphtheria, confervoid filaments were noticed; and in two other cases, one of measles and one of whooping cough, abundant specimens of a small-celled torula were found, and these were seen to increase in numbers for two days, after which they ceased to develop.

These differences in the nature of the bodies met with probably show some difference in the nature of the fluid given off; but it was pointed out that they afford no proof as yet of the germ theory of disease. They simply show the readiness with which the aqueous vapour of the breath supports fermentation, and the dangers of bad ventilation, especially in hospitals.

Dr. E. Lund and Dr. H. Browne stated that they had also made experiments, the results of which were, in general, confirmatory of those obtained by Dr. Ransome.

Ordinary meeting, March 8th, 1870. J. P. Joule, D.C.L., LL.D., F.R.S., &c., President, in the Chair.—The following letter from Mr. Dancer, F.R.A.S., dated March 5, 1870, was read:—

I was not present at the last ordinary meeting on Feb. 22nd, but seeing my name mentioned in the printed report of Dr. A Ransome's paper "On the Organic Matter of Human Breath," in which it is stated "that Mr. Dancer's calculation of the number of spores in the air was noticed, but a source of error was pointed out in the readiness with which organisms are developed in suitable fluids even in the course of a few hours," in reply I have to state that this very obvious source of multiplication did not escape attention, which a few extracts from the printed paper in the Proceedings of March 31st, 1868, will suffice to show. It is stated that "during the first observations, few living organisms were noticed, but as it afterwards proved, the germs of plant and animal life (probably in a dormant condition) were present." Again, at the bottom of the same page—"When the bottle had remained for 36 hours in a room at a temperature of 60° the quantity of fungi had visibly increased, and the delicate mycelial thread-like roots had completely entangled the fibrous objects contained in the bottle and formed them into a mass." I may add that the contents of the bottle were very frequently subjected to critical examination for any change in their appearance from the time I received it from Dr. R. A. Smith until all appearance of vitality had ceased. The amount of solid matter suspended in the atmosphere is exceedingly variable—after continued rain the air is comparatively free, whereas in very dry weather with high wind, in localities where dust and decomposing matter are abundant, it will be found at a considerable altitude.

Brighton and Sussex Natural History Society.*

March 10th. The President, Mr. T. Hennah, in the chair.—The meeting was special, to receive a report of the Committee on the subject of forming a Microscopical Section, a summary of which is appended. It having been suggested that the usefulness of the Society would be much extended if increased facilities could be afforded to its members for microscopical study, the Committee recommended that, as microscopical examination and the use of the microscope were almost indispensable to the pursuit of knowledge in natural history, it appeared necessary to form a section of the Society, to be called the "Microscopical Section," which should provide for the study of subjects connected with the use of the microscope, and for the more frequent intercourse of such members as were interested in microscopical study; that these objects could be attained by monthly meetings of the Section, when papers on strictly microscopical subjects could be read, such reading to be restricted to twenty minutes, so that time might be afforded for the examination of objects and for the comparison of observations; by the formation of a cabinet, to which members be invited to contribute slides, particularly of such objects as illustrate the natural history of Sussex—members to have specimens from the cabinet for home examination, under certain restrictions; and by the encouraging the exchange of slides among the members. The Section to consist of all members of the Society who signify their wish to the Secretaries to join the Section. The government to be under the present officers of the Society until the annual meeting, when the

* Report supplied by Mr. T. Wonfor.

Committee shall suggest rules for its future government: the meetings to be held on the fourth Thursday in each month, at eight o'clock, the chair to be taken by the President, or, in his absence, by a member of the Committee. After the transaction of the ordinary and special business of the evening, the meeting shall resolve itself into a conversazione, at which slides illustrative of the subject of the meeting shall have precedence of other objects of interest and novelty. Before separating the subject of the next meeting shall be announced. On the motion of Mr. Hazlewood, seconded by Mr. Wonfor, it was resolved "That the Committee's report be received, approved, entered on the minutes, and acted upon," the effect of which is to establish a Microscopical Section, and to make the meetings of the Society twice instead of once a month, the first for general subjects of natural history, the second for the microscope in relation to natural history.

The meeting then became general, when a paper by Mr. Clifton Ward, F.G.S., "A Sketch of the Geological History of England, so far as it is at present known," was read by Mr. Wonfor, Honorary Secretary, in which, from the earliest dawn of the Cambrian period to the present day, the changes brought about by submersion, deposition, elevation, denudation, &c., together with an account of the animal and vegetable types of the various periods, were graphically described, while the amount of land above water in England, at the different periods, was represented by a series of fifteen charts.

It was announced that the Bryological Flora of the county of Sussex would shortly be ready for distribution, the Society having determined to publish it at once, instead of waiting until the issue of the annual report.

Tunbridge Wells Microscopical Society.*

The last monthly meeting of this Society took place on Tuesday, April 5, at the house of Rev. Dr. Ash.

There were fifteen members present, and ten microscopes were placed on the table.

The subject for discussion was *Diatoms*. A large number of very beautiful specimens were exhibited, and a general discussion took place as to their nature, and use, and structure, and the best method of viewing them by transmitted light, so as to form a dark background under high powers.

The next meeting will take place on May 3, when the subject of cellular tissues will come under consideration.

* Report supplied by the Rev. B. Whitelock.

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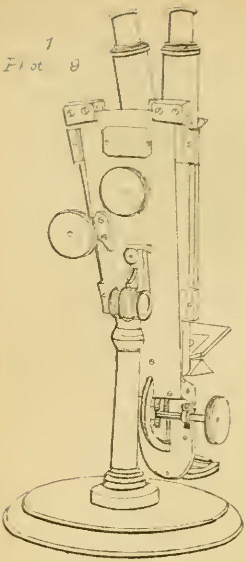
Photo 8



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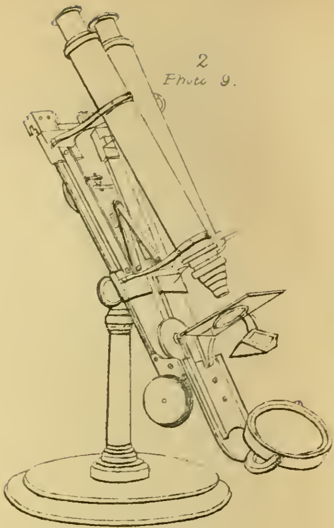

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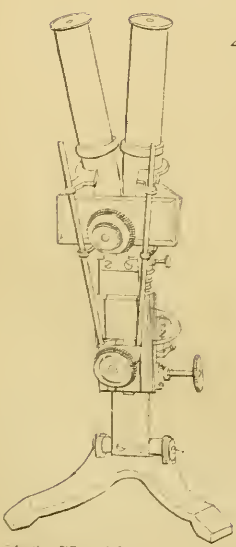

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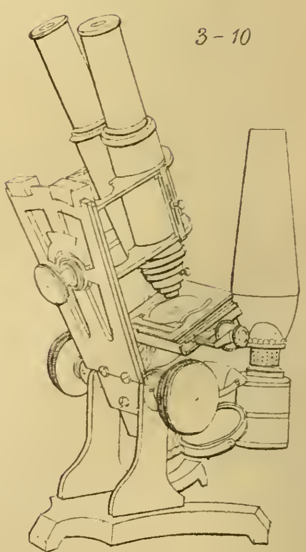

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MONTHLY MICROSCOPICAL JOURNAL.

JUNE 1, 1870.

I.—*The New Binocular Microscope.* By Samuel Holmes.

(*Read before the* Royal Microscopical Society, *May* 11, 1870.)

Plate LIII.

My microscopes are arranged to be Monocular, Binocular, Pseudoscopic, or Stereoscopic, at the pleasure of the observer.

The definition and illumination are equal in both fields of view. They give pictures in solid relief of Opaque objects, and show the thickness of the structure in Transparent objects.

There have been several forms of Binocular Microscope already contrived, but an examination of the principles of their construction shows that much has been left to future endeavour.

In the binocular microscope of Nachet, since, I believe, somewhat modified, we have several extra surfaces of glass for the light to pass through in the necessary prisms, and irrespective of the difficulty of ensuring correct internal transmission through these prisms, their surfaces reflect and scatter the light that a more scientific combination might conserve.

Mr. Wenham's first scheme, of two achromatic prisms over the object-glass, was open to the same objection, and had a similar defect of increased surface although in a less degree, and the difficulty of execution was great from the thinness and acuteness of the prisms.

In Mr. Wenham's second plan, since so deservedly popular, the prism requires nice execution, and depends for the similarity of definition of *its* picture, on the equal transmission of light through a *thick* piece of glass, and on the goodness of its four surfaces.

These difficulties, combined with the error acquired by the unequal length of one set of rays over that of the other set, render it almost impossible to make an instrument on this plan in which the errors are not perceivable by the eye; and thus, although the illusion of solidity is presented to the observer, a doubt has arisen as to whether it has been properly obtained and is to be trusted.

The most perfect piece of glass is variable in structure, and affects the passage of light through it in an irregular manner. This may be called structural aberration, and is reduced to its least effect in all optical instruments by making their glasses as thin as possible.

Hence total-reflexion prisms, by their unavoidable thickness and the number of their surfaces, produce indistinctness that cannot be compensated or removed, and give to the pictures of an instrument in which they are used an unequal appearance and value, the blending of which, by two eyes, can never produce a correct stereoscopic relief.

Largeness of aperture in the object-glass gives a certain relief to an object under view with one eye; this is simply monocular relief, and is untruthfully exaggerated by the two oblique reflexions in the prism, giving a lateral elongation to its image: thus the view of the left eye being rendered dissimilar, presents an appearance of relief when blended with the undistorted view of the right eye.

The amount of this distortion may be seen in the diagram of the prism, &c., in which the two paths of the light to the right and left eye are *produced backwards* until they intersect the plane of the object.

One path is vertical, the other oblique. Now the area of the oblique section is greater than that of the rectangular section, and if the area containing the object is distorted, the object is distorted also. Again, as the eye refers the position of an object to the direction from whence the light came, we may reasonably infer that the left eye sees an object considerably to the right of the real one, and the *obliquity* and *lateral displacement* have the effect of making a Cube appear as a Parallopipedon, and a Sphere as an Ellipsoid, and these forms superposed by any stereoscope will give a false perspective of the Cube and Sphere.

From the above considerations, believing that the attempt to divert half the light from an objective to form a secondary image by a total-reflexion prism, to be incapable of improvement, I have experimented in other directions, and have even gained more light and more equality by the use of *two* prisms, having only a single reflexion in each.

In January, 1869, I contributed a paper to the Quekett Club, on some experiments made in the year 1858, which was read by my co-member and friend Mr. George, and to which I now advert only as a matter of history.

In the microscope therein described, I proposed to divide the light from the objective into three portions and direct one half into each eye, through the medium of two reflectors and eye-pieces. The object-glass shown to the meeting was a hemispherical plano-convex lens, and the plane side had two reflecting facets at the binocular angle. This lens was to be placed over the object with its angulated surface at an angle of 45° to the perpendicular, in which direction the rays from the object should reach it from below, to be divided and reflected horizontally to the eyes through two equally inclined eye-pieces.

It was shown that, if the angulated surface was cut *into* the lens, the image was pseudoscopical; but that if the reflectors were made by cutting *off* the lens, the right eye would receive the left image, and *vice versâ*, the result being a stereoscopic view.

Now this contrivance, although optically qualified to give equal binocular pictures, had certain disadvantages that prevented me making further use of it, the greatest of these being, that the body-tubes must be horizontal, while the objective is vertical, which is rather unsightly and quite contrary to practice.

The paper will be found at length in No. 9 of Journal of the Quekett Club, and was noticed in the Monthly Journal of this Society, No. III., March 1, 1869.

The instrument I am now about to describe is on a different principle to the foregoing, and is my latest invention; my first view through the first one completed, dating 19th May, 1869, and I have since been employed in perfecting the mechanics of the design.

Suppose, for illustration, we had a complete and well-appointed achromatic microscope, and we were to make a clean vertical section through the centre of the optical parts and their supporting brass-work.

Now, although completely dissevered, we could see through it just as well as before its division. But the division of the eye-piece being near the eye would be visible, and therefore might be left undivided, as it is mainly with the object-glass that we have to deal.

Now, being in possession of an imperceptibly bisected instrument, if we *consider each half as the radius of a circle whose centre is the focus of the object-glass, we may, by separating the halves of the body at the upper end to the distance between the eyes* and adding two eye-pieces, *observe binocularly any object that was in focus when closed as a single body.* And here we get an opportunity of proving the truth of the opinions of Harris, Goring, and Brewster, previously quoted.

The binocular vision here provided is strictly natural, both eyes being used under exactly the same conditions as when examining an object unassisted at the distance of distinct natural vision, for the two converging optic axes are directed to the same object, and have the same assistance as to magnifying power and illumination, and the relief presented by an object of solidity must be *absolute* for *quantity* and correctness.

The indirectness of the path of the light forming the second image in the Prism Binocular, before referred to, prevents the use of high powers, because the errors become too sensible to be disregarded.

But in the bisected arrangement, the highest power attainable may be used without any bar by principle, provided only that the optician has skill enough to split it without injury, and to remount its halves without deranging its adjustments. And this is a more simple matter than would at first sight appear.

The bisected tube is mounted in such a manner as to allow the motion to focus to be given to the stage, the body having peculiar adjustments of its own.

In adjusting to distinct vision, it is necessary that each half should move the same quantity to and from the object at the *same time*, in order to be in focus at the intersection of the optic axis. This points to the necessity for an adjustment for point of convergence of visual rays.

Now, according to the differing distances between the eyes of different persons, the half of the body must be capable of being drawn wider apart, or of being brought closer together, to ensure a single solid field.

This is the adjustment for visual angle, and on it depends much of the beauty of the stereoscopic effect.

Further, it will be conceded that the perfection of vision of every kind in all cases governs the construction and arrangements of all instruments, and although it would seem at first sight improper to make binocular vision with two instruments of differing powers, yet if a more equable and solid picture *can* be so observed, it shows that the natural focal length of each eye is not identical. Therefore I introduce an *Adjustment* for *Inequality of Visual Foci.*

These principles are carried out mechanically in a very simple manner: Two metal bars are jointed together at the bottom, and the joint is fixed somewhere in the plane of focus of the object-glass, and the halves of the divided body slide to or from the joint of the bars by corresponding attachments.

Part of a rotation of a Mill, connected with the top of the bars, separates the halves of the body to the distance between the eyes, so adjusting for *Visual Angle.*

A second mill is placed near the bottom of the body, and connected by a crank and link to the third mill, which is capable of motion in a vertical slot, and connected to each half of the body by a link; so that if the second mill is turned partially round, it will raise or lower the third in its slot; and this, acting through its links, raises or lowers the two halves of the body *equally*, and so adjusts for *Point of Convergence of Visual Rays;* or, in other words, makes the plane of Horopter coincide with that of the Focus.

Now, if the third mill, while remaining motionless in its slot, be partially rotated, it will raise one half of the body and depress the other half, or *vice versâ.* Thus we can lengthen or shorten the focus of either half of the object-glass, and completely accommodate any *Inequality of Visual Foci* between two eyes.

The illumination of opaque objects is effected by any of the well-known means for that purpose; but I prefer to use a side reflector, because of the light and shade giving the best effect.

For the illumination of transparent objects, an equilateral prism has one of its sides worked into two facets at such an angle as to throw the light from its internal reflecting surface in the direction of the halves of the object-glass, when placed under the stage.

The definition of an object with this angulated prism is far superior to that given by an illuminating lens. For use by lamp-light the incident surface of the prism is made convex, and the light placed in the focus of its convexity becomes parallel before falling on the reflecting surface. The same effect may be produced by a condenser before the lamp.

These microscopes claim to give a truthfully stereoscopic view of both opaque and transparent objects, by the employment of two direct and equal pencils of light, having origin at the object, and giving vision to each eye, under precisely similar conditions, and whose images being equal in illumination and definition, can but give a magnified presentment of an object in all its dimensions when blended by two eyes.

I believe that this Binocular Microscope will be found to give us the power of making perfect Stereographs of the most minute objects, and when these shall be viewed in the common stereoscope a complete idea of form, proportion, and solidity, will be arrived at by mere inspection: and I *have* thought that the application of this principle might lessen the fatigue of astronomical observations, and increase the perception of detail, by the penetration of the gaze of two eyes over that of one alone.

I had the honour of exhibiting the Instruments, Models, Drawings, &c., at the Soirée of the Royal Society for this year, held 23rd April, at Burlington House, when many gentlemen expressed high opinions of the value of the principle. Professor Tyndall declared the depth of the transparent views to be "wonderfully beautiful," and those of the opaque objects to be "perfectly stereoscopic."

APPENDIX.

Illustrations of Construction.

In order to show the very general interest taken in binocular vision I here insert an extract from the 'British and Foreign Mechanic' of Feb. 5th, 1870. It will serve our purpose in other ways, as it is well illustrated, and was published unsolicited:—

"*Improvements in Binocular and Stereoscopic Microscopes.*

"Our readers have many times forwarded queries to us relating to the construction of the binocular microscope; so we think it necessary for their convenience to give an abstract of the specification of Mr. Samuel Holmes, of 12, Brunswick Terrace, Lower Road, Rotherhithe, who has recently secured his improvements in the instrument by a patent. In the full description of the illustrations published in the specification, the patentee observes:—

"My invention consists in the use of two object-glasses or portions of two object-glasses, or of one object-glass divided into two parts, to supply through two eye-pieces a binocular and stereoscopic view of opaque or transparent microscopic objects while illuminated by reflected or transmitted light, and also in the use of certain mechanical means herein described, or their equivalents, for securing the motion in required directions, or rest in necessary positions of the optical parts of such combinations for obtaining monocular or binocular vision.

"*The Objective.*—I take an ordinary object-piece, and by a circular saw divide it along its line of collimation, and afterwards rejoin the halves by screws and steady pins, until as an objective it is in as perfect a state of adjustment as before division. It is then capable of acting as an objective for one or two eyes, according to the position assumed by the two halves under the control of the mechanical part of the instrument when the direct light is stopped out.

"According to another method, I work the lenses of an achromatic object-piece out of divided and rejoined discs of glass, which when finished and fixed in a divided mounting temporarily held together for that purpose may be afterwards separated by dissolving out the cement by which the halves of the discs were originally conjoined.

"Or lastly, I make two whole object-glasses, and fix one into each half of a divided mount, cutting away only such portion as will allow of proper approximation. This method is available for high powers and for binocular use only.

"In all cases I cut the usual screw-thread on the objectives to affix them to the body, and more surely secure their halves in their respective places in the divided body-tube of the instrument by two small milled-headed screws.

"*The Stand.*—Figs. 1, 2, and 3, represent a front, side, and back view respectively of the mechanical arrangement of a microscope according to my invention, and Fig. 4 shows a section of its optical arrangements.

"A reference to these drawings will show that two rules or bars are jointed at one end (like a sector), and this joint is in the plane of focus of the object-glass. The upper ends of the bars are free to separate a distance equal to the width of the two eyes (about 2½ inches), when operated by the upper millhead and its levers, as shown. On these two bars slide respectively the two halves of the bisected tube carrying the object-glass and eye-piece or eye-pieces, according as to whether the body-tube is closed for observing with one eye or separated for binocular use. This sliding motion is given by a crank on the lower millhead, and serves to make the focus of the object-glass coincide with the centre of motion of the two bars. The central millhead gives a separate motion of small extent to each of the half body tubes, when any little inequality of focal length, either of the eyes of the observer or in the glasses, might make one of the two images indistinct. The focussing motion is given by the two large millheads moving the stage to or from the body of the instrument by a rack and pinion. The convenient position for observation is secured (as heretofore) by tilting the whole instrument on the trunnions in the uprights, through which (in this case) runs the pinion actuated by the two large millheads for moving the stage.

"*The Illuminating Lens.*—Immediately under the stage is a lens of large angular aperture, achromatic or not, receiving its illumination from the usual mirror situated underneath, and by a stop of suitable form the light from the lens is directed through any transparent object.

"*The Prismatic Illuminator.*—This is shown at Figs. 7 and 8. It is made from a rectangular or isosceles prism of glass, by working a convex or plane face for the incident surface, and cutting the reflecting surface into two planes at the binocular angle, the emergent surface being left plane. Its convex surface, when placed at its focal distance from a flame, renders its light parallel, which the two inclined surfaces reflect up to the two halves of the separated object-glass when the prism is mounted in an adjustable frame under the stage. If the incident surface of the prism is plane, the course of the light is unaltered in its first direction, and therefore not condensed, as in the case of the prism having a convex incident surface. By the use of this prism the usual mirror is dispensed with altogether, and a far more brilliant and distinct light secured.

"*Stops.*—To prevent false light it is necessary to stop-off the central pencil from the illuminator by a stop of black paper or metal placed between the halves of the object-glass. This stop may or may not have a prolongation, so as to enclose and prevent the entry of light into the angular space between the separated body-tubes, where long draw-tubes are not used for that end. It is unnecessary to use a divided object-glass for a monocular vision, as any of the ordinary powers supplied answer for that purpose, but should the closed divided glass be so required, a narrow stop must be placed so as to prevent the direct light from coming through the slit.

"A reference to Fig. 4 will serve to explain the optical arrangement of this microscope, where each half of the object-glass occupies an equally angular position with respect to the object, and is thus capable of making a distinct image of the object of the same intensity for each eye visible through the two eye-pieces, as shown, the mirror supplying through the illuminating lens the light for transparent objects, or the same may be lighted by the prismatic illuminator without a mirror, while for opaque objects the light is received from a reflector above, or by preference from one side.

"Figs. 5 and 6 explain themselves, as showing a method of applying this divided system to microscopes of the usual make wherein the focussing is done by moving the body of the instrument instead of the stage as previously described.

"The eye-pieces most suitable for use with the divided object-glass are of the inverting or erecting kind, according as to whether the instrument is used as a simple binocular, or as a stereoscopic microscope."

In one of the photographs exhibited to the meeting there is a somewhat different arrangement. The body is twelve inches long, and all parts are more substantial; the radius bars are an inch wide and an eighth of an inch thick, jointed by a broad hinge, and further steadied by strong circular slides ground to the edge of the back plate; they are opened to the width of the eyes by two racks and a pinion operated by a large mill at the back. The coincidence of Horopter and Focus is secured by a wheel and pinion, working a peculiar parallel motion giving action to the firm slides to which the cradle of the body is fixed, and so contrived as to act in any position of the radius bars.

The motion of the stage is great enough to admit the thickest live-box, and a range of powers from 2 inches to one-quarter.

A cradle-joint admits of the body assuming any angular position. It is movable around a vertical centre, and the whole stands on a massive circular foot.

In a second instrument there is a greater range of adjustment for Horopter is obtained by making the body-cradle rigid, and sliding the body *in it* as required, two mills holding it in any position. It is much more compact and portable, and works with a shorter body, has a mechanical stage, parabola for opaque objects, and prismatic illuminator and usual mirror for transparent objects.

Another representation exhibited shows an arrangement in which the body has no motion vertically. Its halves when separated are capable of a partial rotation around the centre of their length, on two axes carried by the racks that separate them on turning the large mill from "Mono" to "Bino."

Two radius bars (now much lighter, having nothing to support) affixed to the stage, alter the convergency of the bodies when the stage is moved to or from the object-glass, and thus *at once* make the Horopter coincide with the Focus of any object-glass used, and the whole is held in position by a clamping screw. The stage has a further and finer motion for focussing to distinctness.

Note.—Mr. Holmes forwarded to us such a multiplicity of drawings that it would have been as inconvenient as undesirable to reproduce them all. Nevertheless, we have allowed his reference to the figures in the 'British and Foreign Mechanic' to stand, as it helps to further explain his views. Our plate has been constructed from his sketches and photographs, as a whole, and is, we think, sufficiently explanatory of the principle adopted by Mr. Holmes.—Ed. M. M. J.

II.—*Reminiscences of the Early Times of the Achromatic Microscope.* By J. S. Bowerbank, LL.D., F.R.S., F.R.M.S., &c.

(*Read before the* Royal Microscopical Society, *May* 11, 1870.)

The excellent annual address of your President, and the accompanying interesting Memoir of the late venerated J. J. Lister by his son, Professor Lister, of the University of Edinburgh, published in the 'Monthly Microscopical Journal,' renders quite superfluous any attempt, on my part, to detail the early history of the improvements of the modern achromatic microscope. I shall therefore restrict my communication to the reminiscences of its early application to scientific investigation.

My first introduction to Mr. William Tulley was in 1828, at the house of a friend to whom he was showing some of his favourite test objects; and before we parted that evening he had kindly engaged to make me such another instrument as the one through which we had been looking. Shortly afterwards, as he was unable, from press of other business, to complete my instrument, he placed in my hands his own, and the original combinations with which to work until he could complete the one ordered by me. He told me that but four such as I had ordered had been made, and that they were in the hands of Mr. Lister, Dr. Birkbeck, Lord Ashley, and himself. Dr. Birkbeck's instrument, after the decease of that gentleman, passed into the hands of my late friend, Mr. George Loddiges, and from that time forward, until his death, we worked together in concert. Every new improvement in combinations by Lister, Ross, and Powell, were examined carefully and critically by us; with Mr. A. White and Mr. J. Page we measured their angular apertures, and tested their centering and definition with minute globules of mercury, and other test-objects, and so did our best to incite the makers to aspire to the greatest possible perfection in the construction of their object-glasses. As the object-glasses increased in power and perfection, we found it necessary to increase the steadiness of the brasswork. Many anxious consultations were held on this part of the subject, and numerous experiments were tried. In this branch of our endeavours at improvement we received important assistance from our late talented friend, Mr. Jackson, to whose mechanical genius and practical dexterity as a workman we are in a great measure indebted for the admirable stability of the best of our modern instruments. The solid bar, with a rabbited groove, carrying the body and stage on one mass of metal, and the rabbited grooved stage, were the inventions of that able mechanic. The first mountings of this description, after the construction of his own instrument, were ploughed by Mr. Jackson for my new microscope, with his beautiful little ploughing machine; the remainder of the work was completed by Mr. Smith; and although the instrument has been in constant use from that time to the present, its working powers, of both the carrier and the White's lever-stage, are as smooth and steady as when first from the manufacturer's hands. And here I may remark, that when the instrument was constructed a rack and pinion stage was also made for it, so that should the lever-stage get out of order the reserved stage might readily be applied in place of it; but from that day to this the lever-stage has never been removed from its original position; all that has been required to keep it in perfect working order being, about once a year, to touch the exposed portions of the working surfaces with a little oil; and then, after working the stage about to spread the oil, to wipe the surfaces with a piece of wash-leather. These progressive improvements in the definition and beauty of the combinations, and in the facility of the mechanical portions of the instrument, tended greatly to the extension of a taste for microscopical investigation, and microscopes rapidly increased in number; but amidst these incitements to a taste for the study of the minute beauties of creation we must not forget the powerful influence arising from the invaluable method of mounting in Canada balsam, which has rendered permanent thousands of interesting objects that would otherwise have served but for a momentary exhibition of their beauties, and have then been wiped off the glass, and lost to future admirers.

This valuable and effective mode of mounting microscopical objects, I am informed by Mr. Topping, was originally suggested by Mr. J. T. Cooper, an eminent analytical chemist, and it was first applied to the preparation of large objects for exhibition by the solar microscope by a person of the name of Newth, who was employed by the late Mr. Carpenter, the optician, of Regent Street, to exhibit them with the microscope, and who subsequently carried on a very profitable trade in objects so mounted. Mr. Bond afterwards obtained the recipe from Newth, and supplied the microscope at the Adelaide Gallery with such objects for a considerable period, but the process still remained a secret.

Some of the objects thus prepared were brought to one of my Monday evening meetings at Critchill Place about thirty years ago by Mr. Goadby, who exhibited them to Messrs. Alfred White, Page, and myself; and you may imagine how much we were interested and delighted by the distinct and beautiful view which we obtained, for the first time, of preparations of wings of butterflies, moths, and other specimens. Having viewed several of them, Mr. White turned to Mr. Goadby, and said, "Well, but how are these splendid things mounted?" "Ah," said Goadby, "that is a profound secret known only to one other gentleman and myself, and I am pledged not to divulge it." This was a sad announcement, but there was no help for it, and so we continued our examination of the objects before us. During the time Mr. Page and I were at the microscope Mr. White was examining some of the specimens with a hand-lens; and as he held up a large-sized one between his finger and thumb on the broad surfaces of the glasses, Goadby said to him, "Don't hold them in that manner, but by the opposite edges, as they have only recently been mounted and will not bear the pressure of the glasses together;" so Mr. White shifted his hold on the glasses to the manner directed by Mr. Goadby, and quickly soiled his fingers by a small portion of the fluid that he had pressed out by his first mode of handling them. Having exhibited the whole of his treasures, Mr. Goadby departed, promising to come again on the following Monday evening with a fresh stock of beautiful objects. After his departure Mr. White said, "Well, I think I know the material in which Goadby's specimens are mounted." I had observed Mr. White repeatedly smelling his fingers, and my curiosity was somewhat excited by his actions; he then allowed us to participate in the odour, and expressed his opinion that the material in question was neither more nor less than Canada balsam. We then arranged to meet at my house on the following Thursday; Mr. White undertaking to find the Canada balsam and I the other necessary materials. On the appointed evening we proceeded to work; Mrs. Bowerbank providently supplying us with a large old iron tea-tray to hold our materials, and well it was that this precaution was taken, as the sequel will prove. Mr. White produced his Canada balsam, and poured out an ample supply on one of the usual sized glass slips, and we then adjusted on the convex surface of the fluid one of the wings of a butterfly, and gently pressed it into the fluid, so as to expel the air from beneath; a further quantity of the balsam was poured over the upper surface until the object was completely immersed in the fluid. A second crown-glass slip was then laid over the first, for thin glass had not then been brought into use, and the two slips were gently but firmly pressed together, and secured in their places by thread bands, and so we proceeded to prepare six or eight objects in succession, and by that time we were fairly brought to a standstill, our fingers being Canada balsamed up to the knuckles, and our hands like the feet of a web-footed animal when we attempted to separate our fingers from each other, so we were compelled to strike work and adjourn to the regions below, where, by a liberal use of spirit of turpentine, yellow soap, and hot water, we cleaned the objects we had mounted and restored our hands to a comparatively clean condition; we then commenced an examination of our specimens, and were amply rewarded by finding that they were in every respect equal to some of those exhibited to us by Mr. Goadby. On the following Monday he made his appearance with a new series of objects, and after having examined the greater portion of them, while one of us was talking to Mr. Goadby, Mr.

White quietly removed his object from beneath the microscope, and substituted one of ours in the place of it, and then invited Mr. Goadby to look at it. He gazed at it for a few seconds with a puzzled expression of countenance, and then throwing himself back in the chair, exclaimed, "Where the devil did you get that object from?" Mr. White, with a look of extreme gravity, replied, in his own words, "That is a profound secret known only to us three, and we are bound not to divulge it." A hearty laugh was the result, and further explanation convinced Mr. Goadby that his secret had been detected, although he would not at the time acknowledge it. Having thus possessed ourselves of the mystery of mounting in Canada balsam without any of the restrictions of secrecy, we spread the knowledge we had acquired far and wide among microscopists, and it quickly became the favourite mode of mounting objects. We soon learned to make our preparations without soiling our fingers, and to clean our mounted objects with a few drops of cold water and a thin knife-blade, without the use of turpentine or any other odorous fluids. I gradually became possessed of a considerable number of beautiful and interesting natural history objects, and their exhibition by the achromatic combinations of Tulley contributed in no small degree to the growing popularity of the microscope.

The fame of Tulley's beautiful combinations spread far and wide, and I was favoured by the visits of numerous eminent men of science of the period, and among them Dr. Marshall Hall, Mr. George Newport, Mr. Kiernan, Mr. Gulliver, Dr. Mantel, Professor Owen, and others, who brought their specimens with them, and verified their more laborious investigations by the Tullian facile combinations. It was at one of these meetings with Professor Owen, while we were examining the human blood, and the learned Professor was speaking of its "globules," that I objected to the term as not being descriptive of double concave circular discs. Professor Owen concurred with my observation, and exclaimed, "From this time forth then they are discs of the human blood." Mr. Kiernan also verified his observations on the structure of the human liver, before the reading of his celebrated paper at the Royal Society, in 1833, by the Tullian combinations in my possession. But, perhaps, one of the most remarkable of my visitors was the great French naturalist Geoffroi St. Hillaire, who paid a short visit to England in 1833. He had read my paper "On the Circulation of the Blood in the Larva of Ephemera marginata," and doubted the possibility of seeing the valvular action of the great dorsal vessel described therein. I had fortunately in my possession some very favourable subjects for exhibiting these beautiful phenomena, and when all was in order, and the great man applied his eye to the instrument, he at once saw the very facts he had doubted, and without removing his eye, he shouted "Ah!" He sat as if glued to it, and did not seem capable of moving from it. His son-in-law, Dr. Martin St. Ange, fed him with the sweet cake that had been offered to him with some wine as refreshment, as he sat gazing at the beautiful sight; but nothing could induce him to remove his eye from the insect until at last a plunge it made in the cell carried it out of sight, and Geoffroi St. Hillaire started to his feet, threw up both his arms, as he strode down the room, and shouted "*Magnifique!*" He remained but six or seven days in England, and during that brief period we had three most agreeable meetings. The fame of Tulley's beautiful combinations brought a flood of visitors to my house, and at last I found it absolutely necessary to appoint a special night (Monday) for our weekly meetings, and to this arrangement I am indebted for my acquaintance with a numerous list of the most eminent naturalists of the age, and among them none was more welcome or more highly valued than your present President, in whom it is unnecessary to say that the lovers of the microscope found a valuable assistant in the improvement of our favourite instrument. The natural result of these periodical microscopical meetings was the introduction of Tulley's beautiful combinations to a wide circle of admirers, and a strong craving among naturalists for similar instruments, the demand for which was duly met by the exertions of the first three eminent firms of opticians, Messrs. Ross, Powell and Lealand, and Smith and Beck's.

The microscope is now firmly established as a household instrument, and an invaluable assistant in aid of the education and mental refinement of the rising generation.

III.—*On an Apparatus for collecting Atmospheric Particles.* By R. L. Maddox, M.D.

Plate LIV.

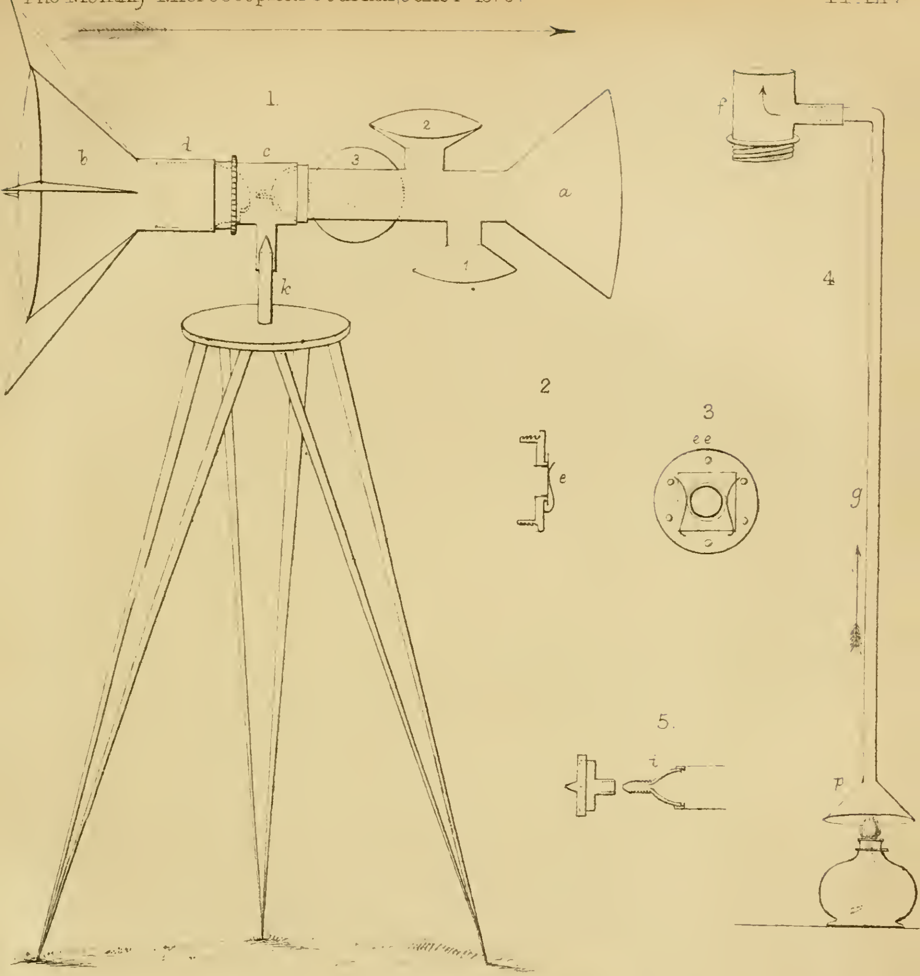
To establish fully any relation between "dust and disease," whether these terms be used in their ordinary or scientific sense, needs an accumulation of evidence which is only likely to be gathered by a multiplicity of observations and experiments, demanding the patient and careful attention of numerous observers, and which, from the minute and varied character of the atmospheric particles, we may expect to long elude our strictest investigations.

Physicists by a beam of electric light may make known the reality of minute atoms floating in the ordinary air, and heat confirm the evidence that some at least are organic in their nature; but these two forces by no means prove those particles living germs; and even suppose they did this, they could not make us acquainted with the genus or species, or prove them carriers of contagion, or whether they were deadly in their nature, or simply germs of innocuous protophytes, at least so far as we know, as regards ourselves.

Nor is the question settled by the application of any mode of straining these particles by a cotton sieve. The utility of cotton in checking their passage has been noted by many observers, and was employed by Drs. Billings and Curtis of the U. S. army, in their experiments related in the valuable Report on the Cattle Plague in the United States, published by order of the Commissioner of Agriculture, 1869, Washington; they confirmed the singular property of bacteria, vibrios, and molecules, passing through moistened filtering paper, while yeast cells are checked, as pointed out previously by Mitzscherlich, and moreover they marked the imperviousness to all these bodies, by vegetable parchment, which permits the transit of fluids.

Dr. Tyndall has shown us that organic matter may escape destruction to a great extent when air is drawn somewhat slowly "over fragments of glass, wetted with concentrated sulphuric acid," also "over fragments of marble, wetted with a strong solution of caustic potash," or when "permitted to bubble through the liquid acid and through the solution of potash," and likewise when rapidly passed through a red-hot platinum tube, containing a roll of platinum gauze. Valuable as these observations are in themselves, we are but little nearer the chief question, which is left open as to the vitality of such organic particles, or their relation to disease.

Is there then any other plan than that which has been adopted by those who have taken pains to investigate for themselves, which may help forward the solution of this question, at least under one aspect? It is not sufficient to gather into water the floating germs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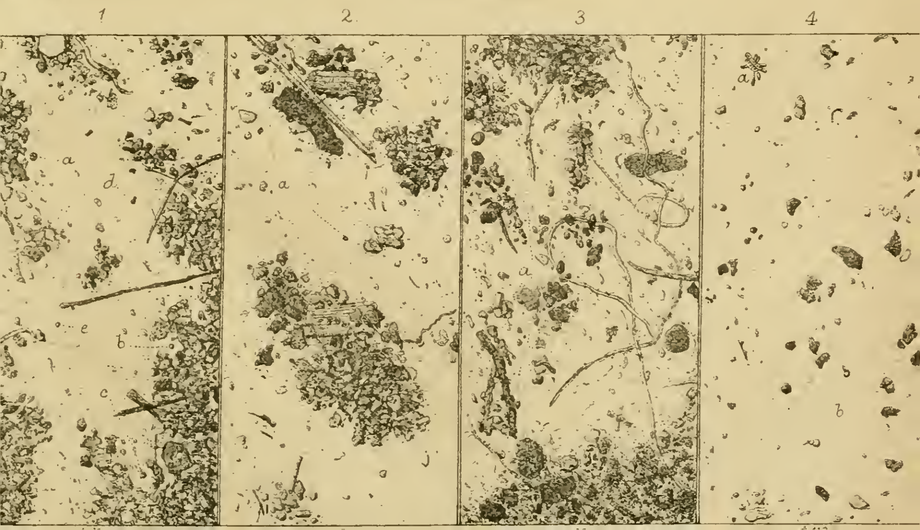
1
2.
3
4
a
b
c
d.
e
a
a
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b

by any form of aspirator, or by shaking together frequently admitted volumes of air and distilled water; for this reason, that before you have proof of having entrapped any living molecules, admitting the purity of the water, you have to allow deposition, decant and examine the deposit by droplets under a high power, at least an eighth objective, and are even then, under the most careful scrutiny, by no means certain that very many of the lightest and minutest have not been either poured away or passed unnoticed.

A most *delicate* scum is sometimes seen on the water prior to decanting the mass; but this, so far as I am aware, has been entirely overlooked, and only the deposit examined; yet such scum has afforded different objects to those in the sediment. I am not in any way alluding to artificial infusions of vegetable, animal, or mineral matter in water; in the two former, the scum is too evident to escape observation. Nor does it follow, if the minutest germs be living, that they should subside at all; they may move through various depths unrecognized. The plan I propose is to try and entrap these atmospheric motes into a small compass, and under ordinary conditions of the external air; then, without allowing more than a few hours to elapse, proceed to their examination; for this reason:—Suppose an apparatus, where the air is drawn for weeks over or through the same water, and let us further suppose numerous germs were obtained, and a due calculation made of even the quantity of air drawn through hourly, it by no means follows that all those germs were drawn direct from the atmosphere, for those which have their habitat in water or damp places may have germinated and divided many times ere the experiment is finished, such subdivision or repetition giving false conclusions; and, moreover, many may have perished under the conditions employed to detect them.

If, then, we can draw these particles into a small space, the next object would be to try and make them pass through at least some of their phases of life, under careful watching with the microscope. Even supposing we have entrapped and developed some of the germs, we shall not have established their relation to disease; to do this would require a very numerous and careful course of observations; but one thing we shall have done, and that is have determined, at least partially, most of the largest of these germs be not those of the commonest forms of mildew, and such as we meet with continually in our food, and which most probably have not the slightest relation to disease, and the minutest, those which are ranged among the monads, bacteria, and vibrios.

To assist in this inquiry I have made the following apparatus as a hollow wind vane, but which can be used in various ways, and by which I hope to obtain results bearing on this important question, which as yet cannot be admitted as settled.

On reference to Fig. 1 (Plate LIV.) it will be seen as in use as a vane; but by changing the position from horizontal to vertical, attaching another short tube (*f*, Fig. 4), with a metal pipe terminating in a small funnel, and placing a lighted lamp beneath it, it can be used over a cesspool in any nook or corner, in an ordinary room, in a cow-shed or stable, or near a patient suffering from any infectious disease.

It consists in the main of two light tin funnels (*a*, *b*) (one rather larger than the other, and supplied with four wing offsets), united by two or more stout brass tubes for convenience of use. The smaller funnel has a diameter of 5 inches by 3 inches in depth, the larger of $5\frac{1}{2}$ inches by $3\frac{1}{2}$ inches in depth. The smaller funnel is continued into a tube of $1\frac{1}{8}$ inch diameter by 6 inches long, to the end of which is fixed or screwed a conical finely-turned cone, with a pipe nozzle (Fig. 5) having a screw thread on its outside and a tapering bore within. On the sides of the 6-inch tube, at alternate positions, are placed three smaller funnels 1, 2, 3. The tube of the funnel fits tightly into the brass tube (*c*), which is 2 inches long by $1\frac{3}{8}$ diameter; the short tube of the large funnel fits over the brass tube (*d*), which has nearly the same measurements as (*c*), and thus the centre of gravity can be easily found.

The brass tube (*c*) has at its junction with (*d*) an internal thread screw, and is free throughout its length. The other tube (*d*) has its external thread screwing into (*c*), but moreover a finer internal thread into which is screwed the diaphragm stage plate (*e*, Fig. 2), and which consists of a thick milled plate of brass, with a fine thread outside, and pierced with a central hole about $\frac{7}{16}$ths of an inch in diameter, and by a series of six small holes external to it (Fig. 3, *e*, *e*). On the side facing the nozzle of the 6-inch pipe of the smaller funnel a narrow ring or raised edge is left in the turning, and abutting nearly against its edge on either side are two bent wire springs. Between this narrow ring and the springs is inserted a *clean thin covering glass*, $\frac{6}{8}$ths of an inch square (Fig. 2, *e*). On the surface of the cover facing the aperture of the nozzle, which can be separated from it a variable distance, is placed a minute quantity of any prepared medium of a transparent and glutinous nature, but somewhat hygrometric, as glycerine or purified treacle with acetate of potash, &c., or the fluid medium, modified if necessary, suggested in my article "Mucor Mucedo," in the January No. of this Journal for the present year; adopting the most useful, if the cover is to be placed on a growing slide (as suggested in the same paper), or in a cultivating apparatus, or to be simply examined without attempts to development.

From the under-surface of the stout brass tube (*c*) is fastened a smaller tube with a solid end, into which is drilled a small conical depression, to receive the pointed end of the support or pivot (*k*), the other end of the support having a screw and nut by which it is fastened to the surface-plate of a tripod stand.

The aperture of the large end of the funnel (*b*) may be partially closed if thought proper by a ventilating fly-wheel, supported centrally by a steel pin with sharp ends embraced between two straps of brass, fastened to the internal face of the funnel by a screw and nut at about one-third of its depth from the open end; its rotation may tend to increase the current when used with a lamp, otherwise it is, I find, unnecessary. To use the apparatus vertically, screw the extra brass tube (Fig. 4) on to (*d*), and slip over the end of the funnel as before; fix into the short tube on (*f*) the gas-pipe (*g*), with its small funnel attached (*p*), and support the whole by one of the retort-holders of the laboratory, or in any convenient way, and place beneath the open end of the little funnel a lighted oil lamp to generate a current above the nozzle; hence it must be placed at such a distance from the apparatus as not to influence materially the current through its proper course. It can be used with water as an aspirator if desired, but my object has been to avoid this. Its position above the surface of the ground may vary from a few to many inches, according to choice. I use it at present 4 to 5 feet above the ground, but think 3 feet may be preferable. If it be desired to test the efficacy of various vapours or fluids as disinfectants or destructive of life in the germs, an extra nozzle (Fig. 5, *h*) can be screwed on the ordinary one (*i*), and made as a flat box having a small nozzle projecting from the cover, looking towards the thin glass. If this narrow box, which should be platinized inside, be packed with fine cotton wool, damped at one part with any article, as creosote, tinct. of the muriate of iron, or solution of quinine, or a particle of hypochloride of lime placed at one part, the particles from the air may be supposed to be entrapped amongst the fibres; but the cotton-wool should, before use, be soaked in absolute alcohol for half an hour, and squeezed dry between heated plates of glass; or gun-cotton might be used if thought more free from error. The wool from opposite the nozzle might, in each case, be removed with a pair of fine scissors and forceps, placed in a deep growing slide with some medium, and set aside for observation. If only a cursory examination be intended of the glass covers, I find a square, half an inch across, drawn on the clean surface of an ordinary 3-inch × 1-inch slide, with a little roll of soft beeswax, makes a very good temporary cell. Care must be taken to apply only a minute quantity of the glutinous material to the centre of the thin cover. If two or three diaphragm stages (*e*) be made, one could be screwed into place when the exposed one is removed.

It is not pretended that this form is the only useful one or the most convenient that can be adopted, but as it has now been in use some days, I find it answer its chief purpose very well, and is exceedingly easy to manipulate. The advantages claimed are, ready application at any spot, the collection of the atmospheric particles *into a small space* in such a manner as to be at once microscopically examined with a $\frac{1}{16}$th or $\frac{1}{20}$th objective, placed on a growing slide, or some form of cultivating apparatus for further observation, or mounted permanently. The difficulty is to select the best cultivating medium. Hitherto I have found besides (*débris*) organic and mineral matters, pollen grains, minute germs of various fungi or protophytes, and excessively minute bodies, "molecules," "globules," &c.; none were seen in motion. All seem to vary in abundance with the force of the wind and dryness of the ground.

This apparatus is deficient as regards crucial tests, but for general use it is efficient, and may, by continued employment, be of service. If any doubt exist as to the medium furnishing the spores, it can be treated as though it had been exposed; hence thus far we have fairness in the results.

I believe it will be only by constant, varied, and multiplied research, we shall ever obtain any answer to the important question of "dust and disease;" hence my excuse for trespassing on the pages of this Journal, in the hope others may be induced to give the apparatus a fair trial or suggest something more useful.

P.S.—The examination of the collections made over forty days has shown that in this immediate locality, at this period, the air cannot be considered as *loaded* with microscopic germs; the largest number visible and counted as such on one cover being twenty-one (not including bacteroid bodies). A few only have germinated; they are under observation.

The photographs were difficult to execute to secure the appearance of the minutest granules, as many of the large particles of sand, &c., were much out of correct focus; still I preferred this method as more truthful than any hand drawing, especially for Nos. 2 and 3. Some of the particles, which, under the low power used to photograph them, appear in the prints as "globules"—with clear centres and dark outlines—with higher powers were found very irregular in form. [The drawings in the Plate are selections from some of Dr. Maddox's photographs.—Ed. M. M. J.]

IV.—*The Magnesium and Electric Light as applied to Photo-micrography.* By Brevet Lieutenant-Colonel J. J. Woodward, U. S. Army.

The following very interesting remarks constitute the report by Dr. Woodward to the Surgeon-General of the United States Army:—

I have the honour to inform you that on the 25th of October last I began to conduct in person a series of experiments, intended to devise means for escaping certain difficulties which had hitherto prevented the successful preparation of Photo-micrographs of specimens selected from the valuable and daily-increasing series of permanently-mounted microscopic sections of normal and pathological tissues, which form so interesting a portion of the treasures of the Museum. In these experiments I used the sun as a source of illumination, and following the process which I have described in full elsewhere,* I had no difficulty in arranging a method by the aid of which this class of objects could be photographed quite as successfully and readily as the diatoms and other test-objects which had previously been so satisfactorily reproduced in this section of the Museum. I shall take occasion in the course of a few days to lay before you prints of some of the tissue-preparations thus reproduced. At present it is my desire to call your attention to certain important observations which I had the good fortune to make while my experiments were in progress, and which it appears to me cannot fail to be of interest and service to all microscopists.

During the last week of October and the first two weeks of November, I relied wholly on the sun as the source of illumination for producing negatives. In this period, during which I had but two perfectly cloudless working days, and several fractional days, on which my work was continually interrupted by passing clouds, I had ample opportunity to convince myself that the uncertainty of the weather was a most serious hindrance to the preparation of successful photographs of microscopic objects, and I ceased to wonder that European microscopists, who are exposed to a climate even more variable than our own, have not yet succeeded in placing the art of Photo-micrography upon such a basis as to make it a convenient and habitual auxiliary in all microscopical investigations. This desirable end I believe I have attained; but it has been by resorting to artificial lights, and thus making the success of the process wholly independent of the weather.

On the 12th of November I commenced a series of experiments with artificial lights, which were most fortunately crowned with success, both the Magnesium and the Electric lights proving adequate sources of illumination for the production of Photo-micrographs even with the highest powers.

For the production of Electric light I used a Duboscq's lamp, set in motion by a battery of fifty small Grove's elements. I found that, with this source of light, photographs could be successfully taken with any power with which pictures can be taken by sunlight; and I was delighted to find, as I had anticipated, that the very exaggeration of light and shadow which has prevented the Elec-

* Circular No. 6, War Department, Surgeon-General's Office, Nov. 1, 1865, page 148 *et seq.*, 'American Journal of Science and Arts,' vol. xlii., Sept., 1866.

tric light from being generally adopted as a source of illumination in the preparation of photographs of the size of the object, or smaller, proved of immense advantage in the reproduction of the feeble microscopical images of highly-magnified objects, and that the pictures were hence clearer and better defined than any photographs of similar objects I had hitherto seen produced by sunlight. I found also that the Electric light was so much more manageable than sunlight as a source of microscopic illumination, that I could readily arrange it to produce negatives with much shorter exposures than are indispensable with the sun.

The Magnesium light shared these qualities to a high degree, but I found that its best work was done when the object was not to be magnified more than a thousand diameters, and that there were certain limitations to its use on test-objects which will be referred to in the sequel.

With one or the other of these artificial lights as a source of illumination, I have prepared a considerable number of negatives of interesting microscopical objects, of which a few are appended to this report by way of illustration, while the others will be laid before you in future reports on special subjects.

The Magnesium and Electric lights are mentioned as possible sources of illumination for the production of Photo-micrographs by Dr. Lionel Beale, in the fourth edition of his 'How to Work with the Microscope,' page 275. I am not aware, however, that anyone has made successful negatives with high powers with either of these lights prior to the experiments here recorded. There are in the Museum a few photographs with low powers taken with the Magnesium light by Dr. C. F. Crehore, of Boston, Mass., who kindly presented them August 3, 1866. Negative No. 90, old Microscopical Series, Army Medical Museum, represents a few villi from the small intestine of a mouse, photographed by the Electric light with a $\frac{4}{10}$th objective of Wales arranged to magnify 84 diameters. The Electric light was produced by forty Bunsen's cells, and as I had no Electric lamp at the time, I held the carbon points in two retort holders, and managed as best I could, during the exposure, the uncertain light thus produced. I know of no other Photomicrographs than the above to have been actually made by the Electric or the Magnesium lights; certainly if any have been, they have not been sufficiently successful for their authors to be willing to give them any degree of publicity. I have no hesitation, therefore, in claiming for the Museum and for myself the credit of having demonstrated the serviceable character of these lights as sources of illumination for the preparation of negatives with high powers, and of having devised a simple method which brings their use within the reach of every microscopist.

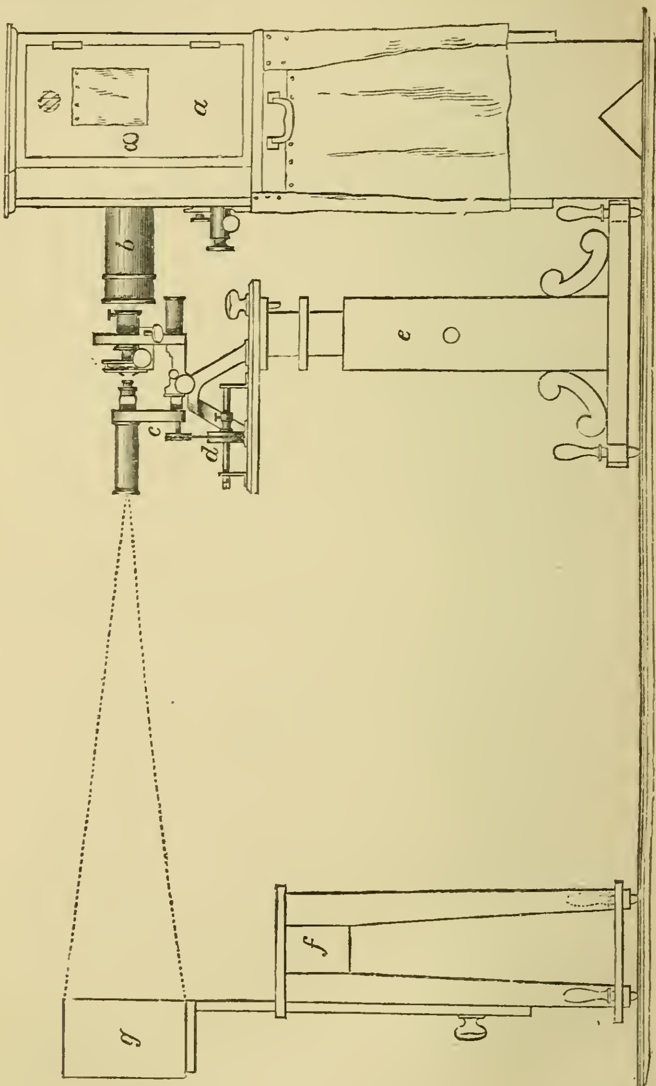
I propose now to sketch briefly the process by which negatives of microscopic objects can be conveniently produced with these artificial lights.

1. The Electric light is by far the best of all artificial lights for the production of Photo-micrographs, and when used, as I am now about to describe, it is both convenient and economical. I use a Grove's battery of fifty elements. The battery is placed just outside of the operating room in a closet, from which the fumes escape through an earthen pipe into the main chimney of the building. This battery was furnished by Mr. William Ladd, Nos. 11 and 12, Beck Street, Regent Street, London, W. The rubber cups are $4\frac{3}{4}$ inches high, $3\frac{1}{4}$ wide, and 2 thick. The platinums are $5\frac{1}{2}$ inches by $2\frac{1}{8}$, and weigh about 60 grains each. The zincs are bent on themselves so as to present a part of their surface on each side of the platinums, and weigh, when new, about a pound apiece. Mr. Ladd furnishes these batteries in trays of ten elements, at five pounds sterling per tray, and I find that a battery of five trays is sufficient for most purposes. Seven pounds and a half of strong commercial nitric acid, and three of sulphuric, diluted with ten times the quantity of water, is sufficient to charge this battery, which will then produce the light continuously for from three to four hours. The cost of running the battery for this time, including in the estimate the amount of zinc consumed, and the cost of amalgamating every third or fourth time of using, is very moderate. I make it a practice to have the battery washed out, the acids thrown away, and the porous cups put to soak immediately after I have done the day's work, and all this is so simple that I have had no difficulty in instructing an orderly to do it, so that the management of the battery does not occupy any part of my time.

The Duboscq's lamp, the microscope, and the plate holder are arranged in a dark room, which enables me to dispense with the use of a camera. The general arrangement of the apparatus is shown in the cut (see next page).

The Electric lamp of Duboscq (*a*) is placed on a stool against the wall at one end of the room, and its light concentrated by a pair of condensing lenses (*b*) on the lower lens of the achromatic condenser of the microscope. The microscope (*c*) (a large Powell and Lealand's stand) is placed on a small table (*e*) which is so arranged that it can be lowered or elevated at pleasure, and can be levelled by means of three levelling screws at its base. The plate holder (*g*), also arranged so that it can be raised or lowered at pleasure, is supported by a small table (*f*) which stands on three levelling screws. The floor of the apartment is quite level. The lenses employed for the microscopes are those of Mr. William Wales, of Fort Lee, New Jersey, specially constructed for bringing the actinic rays to a focus. For powers above the $\frac{1}{8}$th, however, I have found that the achromatic objectives of Messrs. Powell and Lealand, of

London, answer an excellent purpose, and indeed that their immersion $\frac{1}{16}$th exceeds in defining powers any objective which has as yet come under my notice.



In taking photographs with this apparatus, I proceed as follows:—The Electric lamp being set in motion, the table holding the microscope (which has previously been levelled), is raised or lowered and moved from side to side till the centre of the achromatic condenser is brought to the centre of the illuminating pencil proceeding from the lamp; the object is then placed on the stage and carefully adjusted. A cell of plate glass containing a saturated solution of the ammonio-sulphate of copper is fixed just below the achromatic condenser, and not only prevents the admission of non-actinic rays, but excludes the very great heat which accompanies the Electric light, and also moderates its effect upon the eye of the observer. The light thus produced is very agreeable to the eye, and I find myself able to work with it from four to five hours without fatigue. It has also the advantage that all the colours of the object examined disappear, and the preparation appears black on an azure field which resembles the sky on a clear day, so that the observer sees at a glance how the object will appear in the photograph (in which the same black lines or tints will be faithfully reproduced on a white field), and is thus enabled to arrange his achromatic condenser and other adjustments so as to produce the most satisfactory effect.

Everything having been arranged at the microscope to the satisfaction of the observer, the eye-piece is taken out, and, the image allowed to fall on the ground glass of the plate holder, which has previously been placed at the distance necessary to give the magnifying power desired with the objective employed. The operator adjusts the plate holder to the right height and sees that it is perpendicular to the optical axis of the microscope, which he readily does by observing that all parts of the field are equally in focus. He then takes out the ground glass and finishes the fine adjustment with a sheet of plate glass and a focussing glass, after which the sensitive plate is inserted, the exposure made, and the operation is finished.

To enable the observer to focus the microscope while sitting at a distance from it at the sensitive plate, the following contrivance is employed. On the table which supports the microscope (*e*) two brass shoulders, each 2 inches high, are screwed. Through these runs an iron rod 9 inches long, on which slips a brass pulley (*d*) which can be clamped at any point. A cord connects this pulley with the wheel of the fine adjustment of the microscope, which is grooved for the purpose. It is evident that whenever this iron rod is turned, the pulley turning with it will move the fine adjustment of the microscope. To effect this, the iron rod terminates in a square extremity, so that a joint of an ordinary fishing-rod, to which a brass ferrule, shaped like a watch-key, has been riveted, enables the operator to focus the microscope at any ordinary distance. When greater distances are required, two joints of the rod may be used. The rod, being graduated into feet and inches, enables the operator to record the distance employed for each picture.

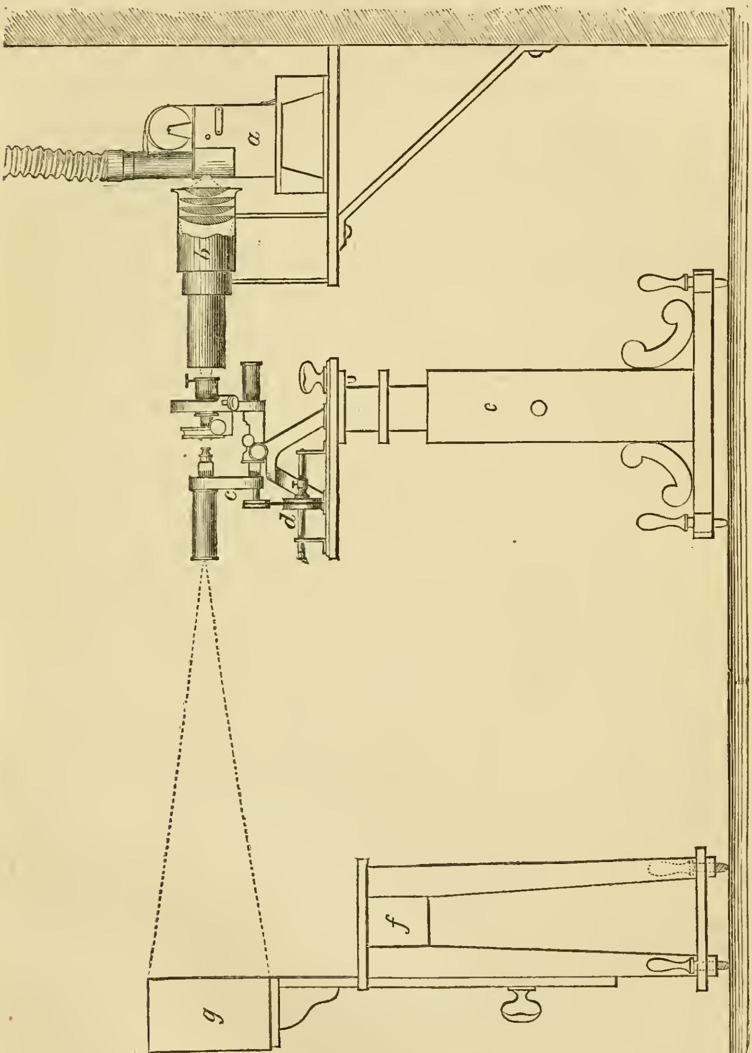
When the focussing is completed, the rod is removed. I have found this simple and cheap arrangement superior in delicacy and convenience to any of the more costly arrangements I have heretofore tried.

The chemical processes employed in taking the negatives do not differ in any respect from those used in ordinary photographic work, and I have found that by employing a practical photographer, allowing him to manage the dark room, and confining my whole attention to the optical arrangements, I not only get many times more pictures in a day, but they are much better than can be produced by anyone who attempts to do the photographic work, as well as manage the microscope himself.

I find myself thus enabled to sit down quietly of an evening, and during four hours' work to produce from twelve to thirty negatives or more, in accordance with the difficulty of the subjects and my previous knowledge of them. Any microscopist who is willing to go to the moderate expense of battery and lamp, and to add two or three specially-constructed objectives to his microscopical apparatus, can, by employing a photographer one or two evenings in the month, reproduce all the more interesting of his month's observations with a decree of economy and beauty not to be obtained by any other means; and if he follows the method I have above described, the character of his results will be conditioned by his skill as a microscopist rather than by any other circumstance. As to the time of exposure required for taking negatives with the Electric light, I find that for 1000 diameters about thirty seconds is necessary for that class of objects (such as Angulatum, the Nobert's plate, &c.) for which it is not necessary to employ a ground-glass plate to prevent interference phenomena. In photographing the soft tissues and many other objects, it is necessary to insert a piece of ground glass below the achromatic condenser, to escape the interference phenomena which else occur, precisely as must be done in photographing the same objects by sunlight. This increases the time of exposure to about three minutes for 1000 diameters. Other powers require proportional times.

2. The Magnesium light affords a beautiful source of illumination comparable to white-cloud illumination of the best character, or to the light of the sun after it has passed through a sheet of ground glass. Without the use of ground glass, this light serves admirably for the production of photographs of the soft tissues with any power under 1000 diameters. The light being composed of a mixed pencil, with rays passing in all directions, there are no interference phenomena; but for the same reason, on the Nobert's plate and many test-objects, the results are inferior to those produced by the sun or by the Electric light; with powers much higher than 1000 diameters, however, the time of exposure becomes inconveniently long.

The process employed by me in the production of negatives with the Magnesium light is essentially the same as I have above described for the Electric light, simply the Magnesium lamp is substi-



tuted for the Electric, and the condenser of an ordinary oxy-calcium magic lantern is made to concentrate the light on the achromatic condenser of the microscope. The above cut represents the arrangement.

The Magnesium lamp (*a*) stands on a shelf fastened against the wall. The condenser (*b*) concentrates the light on the lower lens of the achromatic condenser of the microscope (*c*), which stands on a table (*e*), supported on three levelling screws. The image received on the plate holder (*g*), which is supported on a table (*f*), is photographed precisely as in the case of the Electric light as above described. The same focussing apparatus (*d*) is employed, and the ammonio-sulphate cell should invariably be inserted, but the ground glass is never necessary. I find that it requires exposures of about three minutes to produce negatives of tissue-preparations with five hundred diameters. Other powers require proportionate exposures.

The Magnesium lamp used by me for this purpose was the two-ribbon lamp of the American Magnesium Company (No. 2, Liberty Square, Boston, Mass.), sold by that company for magic lantern purposes, price $50. The ribbon weighs about 52 centigrammes per mètre, and is sold at $2.50 per ounce. Two ounces will, with care, answer for three or four hours' constant work, and ought to produce from twelve to thirty negatives, in accordance with the difficulties of the subjects to be represented. The fumes of magnesia resulting from the combustion are carried into a chimney five feet long, made of a spiral wire covered with muslin, which terminates in a muslin bag, in which the oxide condenses, while the draught goes on through the interstices of the muslin. The chimney and bag are furnished by the company for $2.50.

In commenting on the above processes it may be remarked that for the anatomist and physiological investigator, the Magnesium lamp affords a satisfactory and sufficient source of light for the photography of normal and pathological tissue-preparations. The same end can be equally well or even better attained with the Electric lamp, with which also the most difficult test-objects can be satisfactorily reproduced. Where economy of apparatus is the object, the Magnesium lamp will be preferred by ordinary workers ; but where much work is to be done, the high price of the Magnesium ribbon more than counterbalances the cheapness of the apparatus, and the Electric light becomes the most economical. For the information of any practical photographers who may be employed for work of this character, I may add the following remarks on the chemical process employed in the production of the negative from which the appended prints were made. An ammonium and potassium portrait collodion, rich in alcohol, was employed, developed with the ordinary solution of iron, and fixed with cyanide of potassium. Where it was necessary to intensify, the hydro-sulphuret of ammonium was resorted to.

In illustration of the character of these sources of illumination as compared with each other and with sunlight, I herewith append three prints from negatives, taken with a Wales' inch and a half, from the 6th square of a Möller's diatom type-plate, specially prepared for the Army Medical Museum by that skilful microscopist. The first, from Negative 79 (new series), was taken by sunlight, with 40 diameters; in the second, from Negative 123 (new series), the Magnesium light was used, and everything else remaining the same, the distance was increased so as to give 48 diameters; in the third, Negative 158 (new series), the Electric lamp was employed, and everything else still remaining unaltered, the distance was increased so as to give 66 diameters. It will be understood at once, that on account of the increase of distance, the second picture would have been slightly less sharp than the first, and the third than the second, had precisely the same source of light been employed; nevertheless, in spite of this disadvantage, to which they were purposely exposed, the Magnesium and Electric pictures are far superior to that taken by sunlight, and of the two the Electric is much the best. It is especially to be observed, that in the Electric picture the contrast obtained is so great that the objects appear clearly defined on an almost perfectly white ground, which is never the case with Photo-micrographs taken with the sun as a source of illumination.

As a further illustration of the capabilities of the Magnesium and Electric lights, I add a few photographs taken by each. [Specimens of all these are now, owing to the courtesy of Dr. Woodward, in the possession of the Royal Microscopical Society.]

By the Magnesium Light.

Arachnoidiscus Ehrenbergii. Magnified 400 diameters, by Wales' $\frac{1}{8}$th. Negative 114 (new series).

Small vein and capillaries, from the muscular coat of the urinary bladder of the frog. Magnified 400 diameters, by Wales' $\frac{1}{8}$th. Negative 103 (new series). This negative is taken from preparation No. 3378, Microscopical Series, in which the bladder was injected with a half per cent. solution of nitrate of silver, and subsequently stained with carmine dissolved in borax. The epithelium was then brushed off with a camel's-hair pencil, and the preparation transferred through absolute alcohol to Canada balsam; the photograph reproduces everything but the colour.

By the Electric Light.

Pleurostaurum acutum. Magnified 340 diameters, by Wales' $\frac{1}{8}$th. Negative 109 (new series).

Triceratium favus. Magnified 340 diameters, by Wales' $\frac{1}{8}$th. Negative 110 (new series).

Navicula spima. Magnified 840 diameters, by Powell and Lealand's immersion $\frac{1}{16}$. Negative 112 (new series).

Human red blood-corpuscles. Magnified 1000 diameters, by Powell and Lealand's immersion $\frac{1}{16}$. Negative 145 (new series).

Section of an epithelial cancer of the larynx. Magnified 400 diameters, by Wales' $\frac{1}{8}$th. Negative 162 (new series). This Negative is taken from preparation No. 2277, Microscopical Section. The print shows the nuclei and cells of the growth with great distinctness.

Grammatophora marina. Magnified 2500 diameters, by Powell and Lealand's immersion $\frac{1}{16}$. Negative 151 (new series).

Army Medical Museum, Microscopical Section,
January 4, 1870.

The following note Dr. Woodward has requested us to append:—

War Department, Surgeon-General's Office,
Washington, D.C., *March* 28, 1870.

Note.—Since the foregoing essay was printed, I have obtained a number of excellent pictures, with powers ranging from 400 to 1000 diameters, by using the ordinary oxy-calcium light as the source of illumination. Some of these pictures were not inferior to the best work I have done with the Magnesium lamp; the process employed was the same, and the times of exposure did not materially differ. I will contribute full details in a short time.

J. J. Woodward.

V.—*Remarks on High-power Definition.*

By F. H. Wenham, Vice-President, R.M.S.

I am induced to offer some observations under this head, in consequence of the communications of Dr. Pigott. I had not the pleasure of being present at the reading of the paper before the Royal Microscopical Society, on 10th November, 1869, or I should have made my comments at the time. Considering the large class of observers that employ their microscopes chiefly for the purpose of resolving difficult test-objects, and the form of their structure, it is surprising that the alleged "bead structure" of the *Podura* and other tests has excited so little discussion; and from the partial acquiescence conceded by our respected President, I infer that this structure finds credence amongst a number who interest themselves in such investigations. Not having now the advantage of being able to attend the meetings of the Society, I will take the question as I find it recorded in the Journal, in a fair spirit of controversy, being willing either to receive or give any information that may tend to elucidate the truth.

In the first place, I must take some exception to the slur that is cast upon the object-glasses of our best makers, by the assertion that "in the best glasses there is a certain residuary aberration, which obscures the clear definition under a power of 1000." If such an error does not exist, of course all mathematical calculations for demonstrating its character and amount must be in vain.

The high-power objectives, from $\frac{1}{8}$th upwards, constructed by our first-class makers during the last fifteen years, may now be named as hundreds. Surely some of these are absolutely perfect, if not the majority; and if any error should be present, the development of a peculiar structure in a test-object is not a certain way of detecting it. In this inquiry, it is remarkable how the use of the mercury globule is ignored; yet I have no hesitation in saying that without this test it would be impossible to construct perfect objectives. To the practised eye of the microscope optician, it will develop errors that can be detected by no other means. With a good $\frac{1}{8}$th, for example, under perfect adjustment the spherule appears clear and bright, with the reflexion of surrounding objects shown thereon; and the only fault is that arising from the secondary spectrum, seen as a pale-green halo beyond the focus. It would be desirable to correct or diminish this, but the cure lies more in the hands of the glass maker than the optician. When the globule is thus perfectly defined, if the least possible touch be given to the adjusting collar, altering the distance between the lenses by something less than $\frac{1}{1000}$th of an inch, a kind of fog mars its brilliancy, and is the result of spherical aberration, positive or negative, accordingly as the front lens is either separated or brought nearer. Objects seen by transmitted light are most uncertain tests for these errors of aberration.

If an object-glass is adjusted by a *Diatom*, or *Podura*, viewed by transmitted light, and this same object then illuminated on a dark field, it will generally be found that the first adjustment was imperfect, as a fog now oftentimes obscures the object, which is dispelled by further and more careful adjustment, with the more sensitive test of opaque illumination. Thus in the best objectives we have the power of obtaining equally both positive and negative aberration, and the position between them is free from either—supposing that there are no errors of workmanship. These being under the control of the artist do not frequently occur, and cannot be classed as a constant error.

Object-glasses were made eighteen or twenty years ago with smaller apertures, giving as perfect definition as now. Andrew Ross discovered the adjustment for the thickness of glass-cover

over the object, and demonstrated the nature of the aberration caused thereby. We have here, in the separation or approximation of the lenses of a microscope object-glass, an element of correction which cannot be obtained in the telescope, and which, in constructing the combination, enables us to neutralize the spherical aberrations completely, and, to a great extent, without altering the radii. Objectives, from the hands of careful and experienced makers, have all been constructed on the globule test, and are not sent forth till every error of workmanship, centering, state of oblique pencils, achromatism, and spherical aberration—are obsolutely corrected; for this test discovers the least fault in either, where all others will fail.

But in viewing difficult test-objects with the highest powers, one source of error may occur from the following cause:—If a large angular pencil of rays converging to a focus is transmitted through a parallel plate of glass, an approximation to the form of spherical aberration is produced of a negative character, *viz.* the marginal rays are thrown beyond the central ones. It may easily be demonstrated that this is not exactly identical in form and character with the positive aberration caused by a lens with a spherical surface, and that the operation of bringing the lenses of the microscope object-glass nearer together for the counter-correction, will only neutralize the error within certain limits. The irregular position assigned to the marginal rays by a very thick plate of glass, cannot be exactly reformed by the opposite error caused by closing the lenses; and it is a well-known fact to those experienced in the resolution of test-objects, that some of the same specimens are defined better under one thickness of covering-glass than another.

In the front lens of an object-glass, *thickness* is a very important element of correction. I have explained this in my paper "On the Construction of Object-glasses;"* and in working out a new combination it may be necessary to make several fronts in order to arrive at the exact gauge. If an ordinary "dry" object-glass, perfectly corrected, with a *proper* thickness of the front lens, be used as a so-termed "immersion" lens by the introduction of water between the front lens and covering-glass, this immediately becomes a part thereof, and the excess of negative aberration, both spherical and *chromatic*, is not to be corrected by the usual separation of the lenses. The whole combination has become over-corrected. Rays, which before the introduction of water emerged from the upper surface of the plate in a line parallel to their first incident direction, now pass on in a nearly straight course from their primary refraction from the under-surface of the cover. In order, therefore, to employ an objective as an immersion lens, it becomes requisite to have a *thinner front*, all other radii and corrections remaining the same. The extra or immersion lens should have its thickness diminished by

* Published consecutively in the early numbers of this Journal.

rather less than the thickest covering over the objects that it is to be employed upon.

We have here, in the immersion lens, gone back to the original condition of again adding thickness to the front, and the object may now be considered under view as an uncovered object. Not either the *water* or glass-cover has introduced a single new element of correction, and will not therefore bear out the following assertion in the paper referred to:—"The extraordinary difference between the performance of the hydro-objective and of the pneumo-objective (the plate of air and water making enormous differences in the aberrations of the glasses) must make it apparent to ordinary common sense that our old-fashioned glasses are wrong somewhere."

One advantage in the immersion objective is, that it almost prevents the loss of light from the reflexion of the upper surface of the cover and front of lens, and in part neutralizes any error of figure or polish that may exist between them. There is also another condition annexed, it has the singular property of a *front lens of adjustable thickness,* and therefore can be set to the utmost nicety to balance the aberrations. Of course there is no optical advantage attendant upon the use of *water*. If a medium of the same refractive power as the glass were to be employed the result would be better. Water having a low refractive index, an adjustment is required for each thickness of cover, and a difference of adjustment is not so marked and sensitive as in the ordinary dry objective; but if a medium of similar refraction to the glass were to be used, no adjustment would be required for any thickness of cover, supposing the test-objects to be mounted thereon (which they generally are), for, in fact, we should then view them all with a front of the same thickness—considering the cover, the front lens, and the interposing medium as one.

Having now given some reasons for repudiating the persistent error assumed to exist in all our best object-glasses, I must of course notice the observations upon which the assurance has been founded. The author of the essay expresses his opinion that this "minute structure of the *Podura* affords the most severe trial for residuary aberration with which he is acquainted." I have three $\frac{1}{12}$th object-glasses, and it is most easy to produce the beading with the worst of them. The highest eye-piece should be used, the draw-tube lengthened, and the object placed slightly out of focus. The illumination (with the achromatic condenser) requires long and careful coaxing to obtain the illusion. Figs. 4 to 7 in Dr. Pigott's paper do not fairly represent the appearance. The beads are neither so closely packed or so regular as there shown. The under-beads may appear to cross either to the right or left, according to the illumination or *fancy* of the observer. Having got the beaded form developed to the best advantage, if we now remove the highest eye-piece and substitute the lowest therefor close in the tube, and adjust the focus (which the change of eye-piece requires), the beaded appearance dissolves into the usual "note of admiration" markings. Another appearance may be very easily obtained in the *Podura*—that of a series of oat-shaped cells, each end terminated by a bright spherule; and with equal reason might be claimed as the real structure. Probably no one has ever examined this object so carefully and systematically as the late Richard Beck. With his own hands he collected hundreds of specimens in many localities and of every variety of species. Some of these he gave to me, and which I value exceedingly. I never once heard him express an opinion that the markings were otherwise than longitudinal ribbings. The surest way of deciding the question is by examining fragmentary pieces of the scale. The insects are not easily obtained at this time of the year, or I would offer some illustrations.

At the conclusion of Dr. Pigott's paper he states that "the surface of metals and alloys, with a power of 1000 diameters, shows under reflected light particles, apparently spherical, agglomerated together, with dark lines separating the particles." The plane surfaces of mercury, well-polished speculum metal, or steel, show no structure, but metals with an imperfect surface are full of glittering points which can be developed as spherules. A broken surface of bright points is by no means a practicable test for the correction of object-glasses, for the numerous images interfere and cause a confusion of the indication which is required from a single point only. When a particle of mercury is beaten into fine dust for the purpose of obtaining a very minute point of light for testing errors, a single atom is isolated, as the comas from surrounding ones would embarrass the result. The broken surface of fine cast-steel consists of angular fragments or crystals; a few of the highest can be seen in focus, those beyond appear as spherules.

At page 192 of this Journal, for April, Dr. Pigott states:—"I had the good fortune to discover yesterday that the median line of the *Formosum* is formed of four parallel rows of beads about one-third the size of the general beading. Every part seems compounded of cohesive spherules." I refer to this as an example of how a false structure may be developed in one part of an object of this character by the interference from adjoining parts. Taking the entire scale of the *Formosum*, this four-banded appearance of beads may readily be shown on the median line, and it would be hard to say that they did not exist; but this *Diatom* is exceedingly brittle, and liable to split down the centre, or close to the median line. I have a slide containing numerous fractured specimens; in one, the midrib stands out quite isolated a distance beyond the broken scale. In this portion, not by any means of illumination, or any object-glass that I can employ, am I able to develop a beading or molecular structure;

there is only a faint indication of a core, or median line. In the portion of this same midrib situated in the scale the rows of beads can be made to appear. I have therefore no doubt that they are spurious. In fact, in the *Formosum* the row of beads next to the midrib are much finer, or about half the size of the others, and a spurious image of these can be thrown within the rib.

Under a $\frac{1}{25}$th the *Formosum* is a most superb object. The spherules are perfectly isolated, and appear like beads of coral on a deep sky-blue ground, and at the fractured edge they overhang in some places.

VI.—*On a New Critical Standard Measure of the Perfection of High-power Definition as afforded by Diatoms' and Nobert's Lines.* By Dr. Royston-Pigott, M.A., Cantab., Fellow of the Cambridge Philosophical and of the Royal Astronomical and Microscopical Societies of London; formerly Fellow of St. Peter's College, Cambridge.

The study of Diatom- and Nobert's lines unquestionably rewards the ardent observer for years of application and research. By such studies chiefly microscopy has reached its proud position among the advanced sciences of the nineteenth century. What was deemed impossible ten years ago is now with the microscope a common feat performed at will and at once, as the resolution of Rhomboides, which good observers might formerly be hours in attaining.

Further advances can only be made by searching out errors yet to be remedied: it is unphilosophical to declare perfection has been reached—as a bar to inquiry. The satisfied optician, in the face of modern improvements, is apt to feel it would be far better to let well alone and discourage further refinements in optical science. Our motto must still be "Onward."

The great obstacles to minute observation may be summed up in two words: imperfect correction and exaggerated diffraction.

The former is perhaps insufficiently studied by microscopists, who often purchase their glasses on trust; the latter is a subject which remains to be thoroughly investigated and exhausted. Both these causes distort, derange, and disfigure the true definition of minute objects, and especially the appearance of the celebrated lines of *Nobert's Test-Plate.*

Diffraction lines are not confined to the images of brilliant objects. If a transparent or rather opalescent and pellucid film of a variegated substance traced with dark spots and lines be examined under a high power, when illuminated by the direct rays of the sun, minute *dark* rings may be observed surrounding each dark point, and with every change of the focus the whole surface appears to be in motion with expanding and contracting *dark rings* of diffraction.

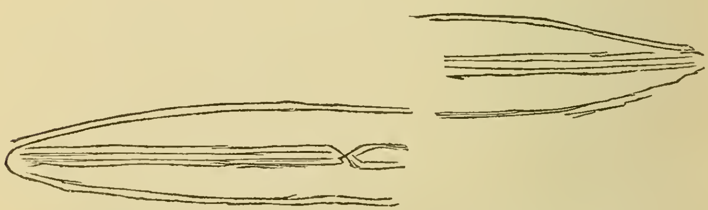
Similarly if the toy-stone called the philosopher's stone enspangled with crystallized metallic points formed in melted glass, which are seen principally of hexagon and triangular form (when brilliantly illuminated with a bull's-eye condenser), be examined with a fine $\frac{1}{4}$th objective, each crystal appears bordered with symmetrical dark diffraction lines varying in number.

Fig. 1.

Indeed, whatever shape the bright object be, it is accompanied by these spectral lines or fringes.

In examining the beads of the Rhomboides I was yesterday surprised to see two halves floating asunder as spectral images from the effect of two oblique pencils, and joining together only when the glasses were properly adjusted.

Fig. 2.



And in the same manner spectral lines in Nobert's bands may be made to float before the eye of the observer. I have thus frequently seen the blank spaces between Nobert's bands crowded with lines more real in appearance than the true.

The central ribs or median lines of the Rhomboides' diatom were also observed to be composed of an extensive rouleau of beads in close contact, much closer set than the general beading, just in the same way as I lately succeeded in distinguishing four rows of beads composing the median lines or ribs of the Pleurosigma Formosum and Angulatum.

The linear Rhomboides' beading was estimated at $\frac{2}{3}$rds closer than the rest. I had not time at my disposal to measure them, but estimate them at about 120,000 to the inch, reckoning the Rhomboides 80,000, which vary very much in different specimens. Nobert's XIXth band would thus appear less difficult of resolution than the central rouleaus of the Rhomboidean median lines, in which sixteen beads appear to occupy the same space as about ten striæ; and as it is the crescentic notch which alone renders the beading visible, which notch is much more minute than the interval between the lines, it may be assumed that an assemblage of minute beading, closely placed in contact, 120,000 to the inch, is more difficult to be seen than parallel lines wider apart; 112,000 to the inch, as in Band XIX.

I now propose to allude to some points that have been made out by the able observers on the other side of the ocean. We are greatly indebted to Mr. Charles Stodder, who, in the 'American Naturalist' for April, 1868, contributes an interesting and elaborate paper on the resolution of Nobert's lines, reflecting the highest credit upon the writer, and which does not appear to have attracted the attention which it deserves. Not many of Nobert's plates have been sold in England; their great cost and difficulty of access, and the fact that many diatoms are known with finer provisional lines than Nobert's, may probably account for this. But still it is scarcely applicable, now, what Mr. Stodder quotes from English works (15 years in print):—

"Mr. Ross found it impossible to ascertain the position of a line nearer than the $\frac{1}{80000}$th of an inch." (1855.)

"Dr. Carpenter (2nd edition, 1859) repeated the same remarks, substituting $\frac{1}{85000}$th for $\frac{1}{79000}$th. There is good reason to believe that the limit of perfection has been nearly reached."

"On the other side (of the water) the late Professor T. W. Bailey claimed to have seen lines $\frac{1}{100000}$th to the inch, and Messrs. Harrison and Sollit the lines of *Amphipleura pellucida*"—now a favourite test-object with Messrs. Powell and Lealand—"120,000 and 130,000 to the inch, and expressed an opinion that lines as fine as 175,000 to the inch might be seen."

"Experiments induced Messrs. Sullivant and Wortly to believe that Nobert's 27th band of lines 81,213 to the inch* gave the limit of resolvability." The objectives used were "Tolles' $\frac{1}{30}$th, aperture 160°. Besides other objectives, $\frac{1}{12}$th and $\frac{1}{16}$th of eminent opticians."

Mr. Stodder then says:—"Dr. Woodward has resolved *finer* lines than any other observer has yet seen, so far as report gives us any information.† With Tolles' immersion $\frac{1}{6}$th, aperture 170°, B eye-piece, power 550, Mr. Greenleaf and myself both saw the 19th band satisfactorily, thus being probably the first ever to see lines 112,000 to the inch. . . . Mr. Eulenstein states that Nachet claims

* A former test-plate. † Old series of bands.

to have seen them by sunlight recently, which claim needs some confirmation, as his No. 10 failed so completely in my hands."

"Since the foregoing was written, Dr. Barnard has made more trials, and I am well satisfied he has seen the 19th band with a Spencer $\frac{1}{12}$th and Tolles' $\frac{1}{5}$th, both dry objectives."

"Dr. Barnard counted the lines five times, giving a mean of 110,820 lines to the inch, instead of Nobert's number, 112,688."

It should now be stated that "Colonel Woodward* declares his belief that Mr. Stodder saw but could not count the lines. At this date spurious lines were so numerous that photographs could not be relied upon for counting them." He concludes his paper with indicating an ingenious mode of counting the lines with a black spot projected upon a plate of glass, upon which the image of the lines is focussed direct from the microscope, without the intervention of an eye-piece. And in a note he says, "Dr. Barnard informs me (notwithstanding the former results), July 21, 1868, that his opinions are not matured, and that he intends to make further observations."

Mr. Mayall, junr.,† writes—"Dr. Woodward seems not to have been sure of the accuracy of the count of his photograph. . . . . He says it shows the 12th band resolved into 37 lines, and further on he says *forty* is the real number in the band."

"It was only after frequent trials that I could be assured of distinguishing readily between the appearance of the two consecutive lines, and those woolly or wavy-looking lines which are shown either by defective illumination or by want of power in the objective, but which are sometimes believed to be imperfectly-ruled lines."

"With the $\frac{1}{8}$th and $\frac{1}{12}$th of Ross, and the $\frac{1}{20}$th by Smith, in the possession of this Society, and with a $\frac{1}{8}$th, $\frac{1}{12}$th, $\frac{1}{16}$th, and $\frac{1}{25}$th by Powell and Lealand, all dry objectives, on a new 19-band plate, all the bands beyond the $\frac{1}{12}$th seemed imperfect—the lines were not separated."

Subsequently, Dec. 1868, Colonel Woodward's paper, 'Further Remarks on the New Nineteen-band Plate of Nobert and Immersion Lenses,' gives us precise details of the resolution, accompanied by a beautiful photograph of the resolved lines, and informs us with a magnanimity which does honour to America:—

"For other lenses carefully tried on the same plate, the $\frac{1}{8}$th Wales, $\frac{1}{25}$th and $\frac{1}{50}$th Powell and Lealand, all dry lenses, resolved the 15th band but not the 16th. . . . . The utmost that a Tolles' immersion $\frac{1}{6}$th, only a strong $\frac{1}{5}$th English standard, was to show the true lines of the 14th band.

"A Tolles' immersion $\frac{1}{10}$th, of 175° of aperture, was received at

* 'Quarterly Journal of Microscopical Science,' Oct., 1868.
† 'Monthly Microscopical Journal,' Feb., 1869.

the museum, May 16th, from Mr. Charles Stodder, who stated in his accompanying letter that it might be regarded as a fair sample of Mr. Tolles' work. With this lens I was unable to see the true lines beyond the 16th band."

"It will be seen, then, that in my hands the best definition was obtained by the immersion $\frac{1}{16}$th of Messrs. Powell and Lealand."

"A careful count of the lines gave the following results:—

15th band	45 lines	18th band	54 lines
16th "	48 "	19th "	57 "
17th "	51 "		

"If Mr. Mayall . . . . has not been able to see the lines in Nobert's plate as distinctly as they are shown in the photographs submitted (to the Royal Microscopical Society), I must presume simply that he has not illuminated the object with monochromatic light."

Mr. Mayall, however, omits to state in his paper that he has employed Powell and Lealand's $\frac{1}{16}$th on the XIXth band, made on the immersion principle.

The rival claims of Mr. Stodder and of Colonel Dr. Woodward to have fairly resolved the XIXth band will be well understood by reading the papers themselves. The congratulations of the microscopists of this country, however, may be honestly conveyed to Dr. Woodward upon his successful photograph of those difficult lines by means of an English objective.

I may now be allowed to state that, after a careful analysis of the experiments detailed in those papers, the following results have been arrived at, which are given in a tabulated form. The convenient method of judging of the dividing power of telescopes by means of close double stars is strongly recommended by the writer to be adopted as a new standard of definition for the microscope as in the telescope. 160″ is the visual angle subtended by the double γ^2 Andromedæ, separated (centre to centre) by $0''\cdot4$ under a power of 400 diameters. This is a smaller angle than any presented by a pair of lines of the XIXth band *counted* at 1000 diameters. But in order to make the calculations sure, the following Table has been carefully computed, beginning with Nobert's VIIIth band, and ending with the XIXth. The principle selected is this: the last line is left out just as in dividing an inch into ten parts we say there are ten lines to the inch, although reckoning each terminal line there are eleven.

Taking, therefore, the usual approximate value for one second $= \cdot000004848$, and for the sake of establishing a standard critical angle for the testing of the performance of the microscope, it will readily be calculated, on the principle laid down in my paper of

May, 1869,* in this Journal, that the lines of Nobert's bands, commencing with the VIIIth band, are separated under the microscopic power of 1000 diameters by the following critical angles (carefully verified):—

TABLE OF STANDARD CRITICAL ANGLES SUBTENDED BY A PAIR OF NOBERT'S LINES.

Nobert's Band. No.	Critical Angles, Power 1000 Standard. ″	Nobert's Band. No.	Critical Angle, Power 1000 Standard. ″
VIII.	407·103	XIV.	244·26
IX.	366·39	XV.	229·00
X.	333·08	XVI.	215·52
XI.	305·33	XVII.	203·56
XII.	281·70	XVIII.	192·84
XIII.	261·72	XIX.	183·20

The performance of American and English glasses, as recorded in the papers already alluded to, may be conveniently referred to this standard as follows:—In the last column I have given the critical angle of resolution, after reducing the given power to a uniform standard of 1000 diameters. In each case the B eye-piece seems to have been used, and the recorded experiments embrace objectives from the $\frac{1}{5}$th, $\frac{1}{10}$th to $\frac{1}{12}$th, $\frac{1}{14}$th, to the $\frac{1}{21}$th focal length.

Nobert has selected the Paris line, which equals $\frac{88815}{1000000}$ths of the English inch, as the basis of his scale. In the first band this is divided at the rate of 1001 lines into 1000 spaces, and each line is $\frac{1}{1000}$th of a Paris line apart.

The	2nd band contains lines	$\frac{1}{1500}$th	apart.
„	3rd „ „	$\frac{1}{2000}$th	„
„	18th „ „	$\frac{1}{95000}$th	„
„	19th „ „	$\frac{1}{100000}$th	„

Recalculating these dimensions, and verifying the results carefully, the lines are separated by the following parts, conveniently represented by the number of divisions to the inch:—

Band.		Band.	
VIII.	50667·115	XIV.	84445·192
IX.	56296·795	XV.	90074·872
X.	61926·474	XVI.	95704·551
XI.	67556·754	XVII.	101334·23
XII.	73185·833	XVIII.	106963·91
XIII.	78815·513	XIX.	112593·59

The first column represents the Angulata of various degrees of fineness, and the second column the Navicula Rhomboides and Amphipleura pellucida, which, however, in many specimens, are finer still.

* 'Monthly Microscopical Journal,' Dec., 1869.

TABLE OF NEW CRITICAL STANDARD MEASURES.

Maker.	Focal Length.	Power, Diameters.	Aperture.	No. of Band resolved.	Seconds, Critical Angle of Observation.	Critical Angle, Seconds, Standard Measure.
			°		″	″
Wales	$\frac{1}{5}$	475	140	VIII.	193·37	407·103
Hartnack	$\frac{1}{14}$	1062	155	X.	353·73	333·08
Natchet	$\frac{1}{12}$	920	..	VIII.	374·53	407·103
"	$\frac{1}{21}$	1600	..	IX.	586·22	366·39
"	$\frac{1}{21}$	1600	..	XII.	450·72	281·70
Tolles	$\frac{1}{10}$	800	160	XII.	225·36	281·70
"	$\frac{1}{10}$	800	..	XII.	225·36	281·70
"	$\frac{1}{10}$	800	..	VIII.	325·68	407·103
"	$\frac{1}{10}$	800	..	XV.	183·20	229·00
Powell & Lealand	$\frac{1}{16}$	1000	170	XIX.	183·20	183·20
Tolles*	$\frac{1}{6}$	550	170	XIX.	100·76	183·20

From this Table it will be seen that by reducing the detailed experiments to one uniform standard test of angular visibility, at a power of 1000, the order of merit in which the performance of the glasses should be placed is dependent upon the closest lines resolved, or rather *counted*.

The XIXth band	resolved	at	183″	by the	$\frac{1}{16}$	Powell and Lealand.
" XVth	"	"	229	"	$\frac{1}{10}$	Tolles.
" XIIth	"	"	281	"	$\frac{1}{10}$	"
" XIIth	"	"	281	"	$\frac{1}{10}$	"
" XIIth	"	"	281	"	$\frac{1}{21}$	Natchet.
" Xth	"	"	333	"	$\frac{1}{14}$	Hartnack.
" IXth	"	"	366	"	$\frac{1}{21}$	Natchet.
" VIIIth	"	"	407	"	$\frac{1}{12}$	"
" VIIIth	"	"	407	"	$\frac{1}{5}$	Wales.

In this result it will be seen that the bands arrange themselves in the order of difficulty of resolution. The XIXth band, at 1000 diameters, closely resembles γ^2 Andromedæ, the severe double star so difficult for telescopes.

It will be extremely interesting to hear that our American brothers can resolve the striæ of known diatoms, having them arranged from 120,000 to 150,000 lines to the inch.

The writer has found in practising upon Nobert's lines some curious phenomena with a Powell and Lealand $\frac{1}{16}$th immersion ($\frac{1}{20}$th converted). Spurious lines can easily be formed by oblique light so as to actually represent the empty spaces between the bands as filled with divisions!

In some cases a false diffraction line exactly divides a pair of lines so as to make *three* instead of two.

* These lines seen at 100″·76 satisfactorily by Mr. Stodder and Mr. Greenleaf, p. 136, 'Quart. Journal Microscopical Science,' July, 1868, quoted *supra*.

The lines appeared the most distinctly and sharply defined when the corrections were so managed with direct light that each groove appeared like a convex cylindrical glass thread.

When the diffraction lines were separated from the real in a particular manner, then they obliterated the true lines altogether.

In other cases the finer lines were transformed into irregular wavy coarser lines, and too few in number; or the band appeared streaked with one or two lines just at points where diffraction lines coincided like *a vernier* with the true, rendering all the rest invisible.

Fig. 3.

Vernier Diffraction Lines (dotted) seen in Nobert's Plate more or less close to the true.

With oblique light the spectral lines appear, as it were, to float away from the true according to the focussing, corrections, and obliquity. The spurious diffraction lines, no doubt, form the greatest obstacle to the full and fair resolution of these celebrated lines. Now, however, that they have been fairly photographed, we may smile at that peculiar prejudice (in favour of a theory) which represented the resolution impossible because of the interpretation of the undulatory theory of light. Even Herr Nobert himself for a long time believed in this impossibility, and has, as far as we are informed, never himself seen the XIXth or even the XVIIIth band. Yet their invisibility depended upon the fault of the glasses, not upon the precision of his truly wonderful ruling machine. In some cases I have observed the ruled lines broken down, as it were, and a fine displaced thread left after the ruling; but the edges of the lines are a perfect marvel of smoothness and truth.

Having tried several experiments upon ruling glass with a diamond point, I have been surprised to find that there was one position into which the axis of the holding tool must be rotated, and one only, in which *true* shavings and curls of glass could be obtained: all other positions causing fracture, chipping, and splitting of the ruled edge of the intended groove. But these beautiful lines are as uniform in general as glass threads, and apparently formed of a semi-circular groove; to which shape probably the diamond is cut by grinding with diamond powder on a soft iron disk to the semi-circular curve, so as to cut and plough a clean and perfect groove at one stroke, and several points are experimented with till the most efficient cutting tool can be selected.

The visibility with a standard power of 1000 diameters may be thus calculated in seconds—

$$\theta'' = \left\{ \begin{array}{c} \text{No. of seconds sub-} \\ \text{tended by a pair of} \\ \text{lines in a band} \end{array} \right\} = \frac{20627 \times 1000\,*}{\text{No. of divisions to English inch.}}$$

and the corresponding angle in seconds is given in the last column of the above Table. In order now to erect a real standard of defining power and tabulate results, the working microscopist having measured by camera lucida the number of *lines* of beading to the inch of any diatom, has only to divide 20627000·0 by the number of lines per inch, and the result in seconds gives at once a standard of the critical angle of observation at 1000 diameters; when the nearer it approaches 183″ the closer will his observation equal the celebrated test of Nobert's XIXth band. In the writer's opinion, some of the finer diatoms, especially the more delicate specimens of Rhomboides, are equal to the XIXth band test, and the beading of which, the central lines or ribs forming the median line being much closer in contact than the XIXth band of Nobert, is one half more severe.

But all European microscopists will long acknowledge that a world-wide microscopy is deeply indebted to the genius of Herr Nobert for the production of his exquisite workmanship on glass.

Mr. Stodder informs us that Dr. Barnard made five counts of the XIXth band with a Spencer $\frac{1}{12}$th and a Tolles' $\frac{1}{5}$th, and that (January 29, 1868) he writes that the observation was made with dry objectives. The mean of the counts are reckoned at 110,820 lines to the inch instead of 112,688.

Dr. Woodward gives the number of lines per millimètre per inch taken from Harting, and Mr. Stodder, the number to the English inch, on the principle that if a thousand and one lines are drawn in a given space, there are 1000 spaces and 1001 lines; but as it is the separating interval with which we are concerned, from the centre of one line to the centre of the next, I prefer considering each separation the $\frac{1}{1000}$th instead of $\frac{1}{1001}$ for Band I.

English microscopists would greatly esteem a statement of Dr. Barnard's own results. We on this side of the water can only felicitate our American friends upon every advance they can make ahead of us here, even though they surpass us.

Few observers could equal Mr. Stodder's keenness of sight in clearly and satisfactorily resolving the XIXth band with a power of 550, as it implies a critical angle of 100 seconds, a thing, however, by no means impossible, although it is equivalent to discerning

* I may add the more correct value of the factor 20627000 is to be found by dividing unity by the value of a second, sin. 1″ = ·0000048481368, and for any other power P and number of divisions N, $\theta'' = 20627 \times \frac{P}{N}$ or $20627 \times P \div N$.

with the naked eye 112 lines drawn to the inch, placed at ten inches' distance. *Counting* them is another thing altogether.

Since writing the above remarks, I may add that a careful examination of Dr. Colonel Woodward's wonderful photographs of Nobert's lines, including the XIXth band, shows spurious lines at the left hand of the striated bands much more distinctly delineated than the band itself. Indeed, the XIXth appears flecked with a peculiar waviness, mottled as it were with the tremulous motion of a heated stratum of air as seen through a land telescope on a hot summer's day. The lines are *there* indeed, but more or less continuous. I am of opinion that were Dr. Woodward in possession of the $\frac{1}{8}$th or $\frac{1}{16}$th recently constructed by Messrs. Powell and Lealand, either as dry or water lenses, the lines of the XIXth band would now be pictured as sharp and clear as the spurious lines at the edges, which will be probably reduced by a better definition.

Dr. Woodward distinctly states that Mr. Stodder and Mr. Greenleaf were not able to *count* the lines. So low a critical angle as 100 seconds, indeed, could hardly enable the acutest sight to perform such an optical feat. Our distinguished President informed me he could see telegraph wires $\frac{1}{4}$ inch in diameter at 800 yards' distance, or a subtense of one in 115,200 : or as one in 206,270 nearly equals one second, the telegraph wire would thus be slightly under *two* seconds. We may conclude that very keen eyes may see a line only two seconds in diameter. Nobert's XIXth band, with a power of 550, gives a hundred seconds between the centres of each contiguous line, yet it required a power of 1000 diameters and a critical angle of 183″ to enable Dr. Woodward to so discern the line as to be able to count them with certainty with our best $\frac{1}{16}$th immersion of that date. Without entering into any description of the optical causes which render these lines so indistinct, even at 200 seconds of separation in the microscopic field, an interesting account might be given of the sensibility of the eye as affected by "personal errors of observation," and the ordinary discriminating vision of average observers.

But any one who can count the lines with 250 on the Angulatum will perform almost the identical feat claimed by Mr. Stodder. For this gives nearly a critical angle of 100″, reckoning the lines of Angulatum 52,000 per inch.*

There is nothing in the nature of vision to divorce microscopical from telescopic fields of view. In both cases the final image is presented to the eye for vision by the eye lens at its focal points in the plane of the stop. In both the actual image is seen not close, but a distance of ten inches, more or less, from the eye. The experience of astronomers therefore gives a rich fund of data for estimating

* $\theta = \frac{20627 \times 251 \cdot 85}{52000} = 100'' \cdot 1$ nearly.

keenness of vision and its measures as applied to the microscope. Microscopists can draw largely, therefore, on such recorded observations. It has already been observed that the smallest angle at which parallel lines can be numerically distinguished with a high power of 1000 diameters is 183 seconds, or in round numbers 200 seconds. Now there is a singular congruity between this critical angle and that required for fairly dividing the most difficult double stars.

The celebrated Mr. Dawes, so renowned for observing powers, the discoverer of Saturn's inner gauze ring like a crape veil, proposed "α Polaris," which has a small companion of the ninth magnitude, $18''\cdot 6$ distant from the pole star, as a general standard test, if the telescope and eye of the observer are good, for a power of 80 diameters. Now, in the field of the eye lens, this double gives a critical angle of $80 \times 18''\cdot 6$, or $149''$ nearly. Considering the brilliance of the pole star compared with the faintness of the companion, it is indeed a very severe standard test for the human eye. But I will venture to relate a few more examples of critical angles of definition:—

	"		Diameters.	Critical Angle. "
γ^2 Andromedæ ..	$\frac{1}{2}$	apart, seen with	300 ..	150
ϵ Bootis	2·7	" "	80 ..	216
ζ "	1	" elongated with ..	250 ..	250
μ^1 "	0·48	" finely divided ..	370* ..	177·6
α^2 Cancri	1·4	"	144 ..	201·6
ζ "	0·6	" "With" mirror	300 ..	180
η Coronæ Borealis	1·0	apart, one of Herschel's severest tests	450 ..	450
ψ^2 Orion	2·8	apart, $9\frac{1}{3}$ silver mirror	212† ..	593·6

There is a curious similarity of these critical angles, at which the double stars were resolved, to the angles at which Nobert's lines were seen with various instruments and powers.

* Browning's silver-glass telescope, $10\frac{1}{3}$th inch aperture.

† These examples of definition are taken from 'Celestial Objects for Common Telescopes:' Rev. T. W. Webb.

[Professor EDWARDS' paper "On Diatomaceæ."—Owing to great pressure on our pages the continuation of this article is unavoidably postponed.]

NEW BOOKS, WITH SHORT NOTICES.

Protoplasm; or, Life, Matter, and Mind. By Lionel S. Beale, M.B., F.R.S. 2nd Edition. London: Churchill, 1870.—We have only to state in reference to this the second edition of Dr. Beale's interesting book, that it is much enlarged and contains a new section on the Mind. It is an able display of the author's well-known views in reference to the early development of the tissues, and embraces an attempt to apply these views to some of the problems, half physical, half metaphysical, which of late years have attracted the attention of thinking biologists. Whatever opinions may be held as to the dispute between Dr. Beale and Mr. Huxley, it is certain that the volume itself is full of interest both to the microscopist and the ordinary educated man.

The Cell-doctrine: its History and Present State, &c. By James Tyson, M.D., Lecturer on Microscopy in the University of Pennsylvania. Philadelphia: Lindsay & Blakiston, 1870.—It is surprising how very little is known by medical men generally of the arguments for and against the cell-doctrine of Schwann and Schleiden. Notwithstanding the admirable essay published by Professor Huxley many years since in the 'Medico-Chirurgical Review,' and the numerous fine memoirs which Dr. Beale has given us from time to time, it is still a fact that very few know how the question as to the mode of origin of the tissues now stands. It was to meet this want, and, at the same time, to help to promulgate Dr. Beale's views, that the author of the present volume prepared this treatise. The book is in great part a compilation, but it also details some original observations of the author's. It contains a handsome coloured plate, copied from one of Dr. Beale's works, and has a few woodcuts intercalated in the text. It is further provided with a most copious bibliographical list, which (although some of the names are misspelt here and there), must prove very useful to those engaged in investigation on this subject. As we have said, it is in great part compiled, and treats historically of the different opinions on the generation of the tissues which have been put forward both before and since the time of Schwann and Schleiden's famous essays. It is the first book in which we have seen any thorough epitome and fair recognition of Professor Huxley's views; and though Dr. Tyson dissents from these, as he does from many others, we must say that his statement of the several opinions of conflicting anatomists is characterized by fairness, clearness, and honesty. We said that one of his objects has been to support Dr. Beale's ideas, but this requires more qualification; for, though he gives a general adhesion to Dr. Beale's doctrines, he dissents from these in so far as they give a structureless character to the germinal matter. In the author's own words, "We deem it incorrect, therefore, to describe germinal matter as in all instances structureless, and prefer with Robin to describe it as sometimes granular. Indeed, if we mistake not, Dr. Beale, in his earlier descriptions, also characterized it as granular."* The book is one which every student of general histology should possess. It is, unquestionably, the most comprehensive essay on the whole subject which has yet been published.

Zeitschrift für Parasitenkunde. Herausgegeben von Dr. Ernst Hallier, Professor der Botanik in Jena, und Dr. F. A. Zürn. Erster Band. Jena: Mauke's Verlag.—We hope to notice this the first part of a new and valuable journal of Parasitology more fully in our next number. In the meantime we would direct our readers' attention to it. It is a thick 8vo journal, with six large folding plates, and some hundreds of exquisitely-drawn figures of vegetable (fungoid) parasites of different kinds, and contains some thirty different communications on various departments of parasitology.

Recherches sur la Composition et la Signification de l'œuf, basées sur l'étude de son mode de Formation et des Premiers Phénomènes Embryonnaires. Par Edouard Van Beneden, Docteur en Sciences Naturelles, Bruxelles. Hayez, 1870.—It is only necessary to say of this splendid quarto that it is the great memoir which obtained the prize offered by the Belgian Academy for the best essay on "The Anatomical Constitution of the Egg in the different Classes of the Animal Kingdom, its Mode of Formation, and the Signification of the different Parts which compose it." The work, which has been "crowned" by the Academy, is, it must be confessed, one well worthy to take its place beside the great memoirs of Von Bär and the other masters in embryology. The aim of the author has been to show the relation between the ovum and the cell, and thus to demonstrate whether any and what analogy exists between the ova of different classes of animals. In a word, these labours have been directed to the discovery of those differences which exist between the ovum as the product of a single gland, and the ovum as it proceeds from two separate glands, "germigenous" and "vitellogenous." In dealing with this complex question, M. Van Beneden has investigated the structure and development of the ovum in an immense multitude of species ranging over the intestinal worms and Turbellaria, Crustacea, Birds and Mammals. The fruits of his work are recorded in nearly 300 pages which constitute this essay, and are figured in the twelve admirably-drawn plates appended to the text. In addition, there is furnished a very able historical sketch of the progress made in the knowledge of this branch of embryology. The chief conclusion at which the author arrives has been already in part stated in a paper which appeared in these pages, but it may thus again be stated:—"In every ovum, whether of a mammal or a bird, a crustacean or a Trematode, we find a protoplasmic cell whose nucleus is the germinal vesicle, and whose nucleolus is Wagner's corpuscle.

* 'Archives of Medicine,' vol. ii., p. 189.

This, which we have termed the germ, or egg-cell, and which we regard as the first cell of the embryo *se forme partout de la même manière;* it always presents the same characteristics and produces by division the first cells of the embryo. But the vitellus of the egg is composed of two elements; the one, the protoplasmatic, represents the substance (*corps*) of the egg-cell; the other, the nutritive, forms what we have called the deuto-plasm of the ovum. This deuto-plasm is the accessory part of the vitellus; it is sometimes absent, arises in various ways, presents un-uniform relations to the protoplasm, and undergoes very different operations in the course of the first embryonic phenomena." M. Van Beneden's treatise is one which should be in the library of every student of natural science.

PROGRESS OF MICROSCOPICAL SCIENCE.

The Relation between Ascidians and Vertebrates.—This important fact, which was mooted a couple of years since, seems to be better established every day. In the last number of Max Schultze's 'Archiv' (Band VI., Heft 2) Professor Küpffer, of Kiel, has a very important paper on the subject, illustrated by three exquisite plates detailing the development of *Ascidia canina.* The memoir will well repay careful study.

The Ganglion-bodies of the Cerebrum.—Dr. Rudolf Arnt, of Griefswald, contributes to the above journal a very valuable paper "On the Structure of the Nerve-cells of the Brain." He especially describes the peculiar ganglion-cells whose prolongations, several in number, can often be traced to a considerable distance, thinning out and ending in exquisitely delicate filaments, which are covered with minute globular particles attached to them almost as grapes are on a stalk.

Terminations of the Nerves in the Skin.—Herr C. J. Eberth, who has been working at the problem of the mode of termination of the nerves in the skin, has published recently the results of his inquiries, especially with regard to the skins of dogs and cats. Many of his preparations were made with the chloride of gold solution, and they lead him to believe that the nerve filaments pass even beyond the papillæ, and apparently travel through the basement membrane and into the epidermis. The gold solution, however, is possibly a dangerous one for inquiries of this delicate kind, and it certainly seems as if Herr Eberth's drawings were capable of another interpretation than that which he puts upon them.—Schultze's *Archiv*, Band VI., Heft 2.

A New Microtome, which will interest some of our readers, is described in the last number of Max Schultze's 'Archiv,' by Herr W. His. Its construction is too elaborate to be described without the aid of the woodcuts contained in the paper. Its cost is about 5*l*.

Animal Life at Great Depths in the Ocean.—So much interest has attached to this subject since the publication of Dr. Carpenter's interesting report, that the history of the progress of discovery in this direction is especially attractive just now. Those who wish to read a short but well-condensed account of the development of our knowledge of this subject will find it in a paper by M. A. J. Malmgren, in Siebold and Kölliker's 'Zeitschrift' (April 1st). Beginning with the earlier observations of Sars, Koren, Danielssen Loven, and others, it then deals with the labours of Edward Forbes, Dr. Wallich, Milne Edwards, and at last brings us down to the inquiries of Carpenter, Thomson, and Gwyn Jeffrys.

Structure of the Central Nervous System of Vertebrates.—One of the longest and most important memoirs published on this subject is that by Professor Ludwig Stieda, of Dorpat. It is not very abundantly illustrated, but it gives not only the author's own observations in detail on the whole central nervous system in various animals, but deals critically with those who have devoted attention to this subject, and especially our distinguished countryman, Mr. Lockhart Clarke. It extends over nearly 200 pages.

Termination of the Nerves in Glands is the title of a fine paper by Professor Krause in the last number of Reichert's 'Archiv für Anatomie' (April). The author traces the nerves to the follicles of the glands, and sometimes to the cells.

The Structure and Affinities of Sigillaria.—Principal Dawson's (of Montreal) views on this subject differ in some particulars from those of Mr. Carruthers, whose interesting papers have appeared in these pages. In a memoir communicated to the Geological Society (May 11th) the following account of the above is given :—With reference to Sigillaria, a remarkably perfect specimen of the axis of a plant of this genus, from the coal-field of Nova Scotia, was described as having a transversely-laminated pith of the Sternbergia type, a cylinder of woody tissue, scalariform internally, and reticulated or discigerous externally, the tissues much resembling those of Cycads. Medullary rays were apparent in this cylinder; and it was traversed by obliquely-radiating bundles of scalariform vessels or fibres proceeding to the leaves. Other specimens were adduced to show that the species having this kind of axis had a thick outer bark of elongated or prosenchymatous cells. The author stated that Professor Williamson had enabled him to examine stems found in the Lancashire coal-field, of the type of Binney's *Sigillaria vascularis*, which differed in some important points of structure from his specimens; and that another specimen, externally marked like Sigillaria, had been shown by Mr. Carruthers to be more akin to Lepidodendron in structure. These specimens, as well as the *Sigillaria elegans* illustrated by Brongniart, probably represented other types of Sigillarioid trees, and it is not improbable that the genus Sigillaria, as usually understood, really includes several distinct generic forms. The author had recognized six generic forms in a previous paper, and in his 'Acadian Geology;' but the type described in the present paper was that which appeared to predominate in the fossil Sigillarian forests of Nova Scotia, and also in the mineral charcoal of the coal-beds. This was illustrated by descriptions of structures occurring in erect and prostrate Sigillariæ, on the surface of Sternbergia casts, and in the coal itself.

The Relation of Vorticella to Actinophrys.—In a letter published in 'Scientific Opinion' (May 11th) Mr. C. Staniland Wake records some interesting observations on this subject. Having described his method of making a number of organic infusions, and stating the nature of the bodies subsequently found in them, he says:—The infusions produced, moreover, bodies of a circular form, which I have now little doubt were encysted forms of Vorticella. In addition to these, however, were a number of larger bodies of different shapes, the nature of which I could not for some time determine. That they were animal organisms I did not doubt. Their appearance—that of a nearly circular and nucleated cell, with an outer faintly-defined rim—was sufficient to induce this belief. No motion was at first noticeable, but I soon found that the shape of these bodies altered, and I at once set them down as having an amœbal character. This idea appeared to be confirmed by the fact that free-moving amœbæ were also present in these infusions. I have not studied the changes of Vorticella, and therefore I was much surprised, on examining these infusions some days later, to find a great number of these forms in full activity. What is the explanation of this fact? It was soon made apparent by a reference to Pritchard's fine work on Infusoria. At plate 27, Pritchard gives several figures of *Vorticella microstoma*, this being, I have no doubt, the form which was so plentiful in my infusions. On plate 23, moreover, several forms are figured, which I at once recognized as those which I had supposed to be amœbal. In Pritchard these are classed with *Actinophrys*, but they are described as having been figured by Stein as phases in the development of *Vorticella microstoma*. Eight of these phases are given by Stein, and of these Nos. 1 and 2 in Pritchard almost perfectly represent the forms produced in my infusions. In addition, however, to *Vorticella microstoma* were several other analogous forms, among them one much resembling *Actinophrys linguifera* or *Acineta* (Pritchard, pl. 23, fig. 17). Since I noted the above facts, most of the Vorticella have disappeared, and the circular bodies have increased very largely in number, the smaller ones being extremely numerous. These bodies are nearly always associated with the fungoid matter. They evidently increase in size, and seem to me to be phases of the encysting process of *Vorticella microstoma*, as figured by Dr. Carpenter in his work on the Microscope. In addition to the infusoria referred to, the infusions now contain several other forms, among them *Kolpoda cucullus*.

NOTES AND MEMORANDA.

A Graduating Diaphragm.—In a recent number of the 'Chemical News' there appears a letter from Mr. Henry Morton, of the Franklin Institute, Philadelphia, in which he quotes from the Journal of the Institute (February) an account "of a new and very ingenious contrivance by Mr. J. Zentmayer." The instrument is a graduating diaphragm. It consists of two cylinders or rollers with parallel axes and surfaces in contact, having similar conical grooves on their surfaces, and fine teeth cut at one end of each, which, gearing together, cause them to rotate in unison. There is, theoretically, an objection to a diaphragm of this construction, from the fact that its opening will not always be in the same plane—that is, the smallest cross-section of the space between the rollers will not always be equidistant from a plane at right angles to the line of sight and passing through the axes of the rollers. With the larger opening, this smallest section will be nearest to, and with the smaller, farther from, such a plane. In practice, however, this difference is so small as to be entirely unimportant, and may even, in some cases, be turned to advantage. There are other forms of gradually adjustable stops which have been employed with more or less success, but few, according to Mr. Morton, involving so many elements of durability and convenience.

A New (?) Combination Objective.—At the meeting (March 9) of the Microscopical Section of the Boston (U.S.) Natural History Society, Mr. C. Stodder exhibited a new objective of unique construction made by Tolles. With its draw-tube closed it was a 3-inch; when fully drawn out, a 4-inch; it had a working distance of only $1\frac{3}{4}$ inch. He also remarked that Professor Eulenstein had written him that Nobert and himself had resolved the seventeenth band of Nobert's test-plate with a $\frac{1}{6}$-inch objective made by Tolles; they had been unable to do so with any other objective.

The Schooner-yacht 'Norna' has started on her trip of dredging on the west coasts of Spain and Portugal. Her owner and master, Mr. Marshall Hall, is accompanied by Mr. W. S. Kent, of the British Museum; and as Mr. Kent is one of the active members of the Royal Microscopical Society, we may expect good results from his labours.

Dr. Michael Foster, the eminent Teacher of Microscopic Anatomy in University College, and one of the Secretaries to the Biological Section of the British Association, has been elected Prælector in Physiology at Trinity College, Cambridge.

A New American Natural History and Microscopical Society.—There has just been started in the city of Baltimore a society of fifty members, called the "Maryland Academy of Sciences." It is intended to pay special attention to microscopy. The following list of the officers may be useful to those societies which desire to correspond with the new Academy:—Philip T. Tyson, President; John G.

Morris, D.D., Vice-President; Edwin A. Dalrymple, D.D., Corresponding Secretary; Charles C. Bombaugh, M.D., Recording Secretary; John W. Lee, Treasurer; P. R. Uhler, Curator; A. Snowden Piggott, M.D., Librarian; J. B. Uhler, J. De Rosset, M.D., and F. E. Chatard, jun., M.D., Assistant Curators.

Mr. Carruthers' New Monograph.—Among the new monographs to be issued by the Palæontographical Society is one by Mr. W. Carruthers, on the Fossil Cycadeæ. We look with interest to the appearance of the work, and we believe that it will demonstrate very effectually the great value of the microscope in palæontological researches.

The Chair of Physiology in Prague.—This chair, which was previously held by the late Professor Purkinje, an Honorary Fellow of the Royal Microscopical Society, has been given to Herr Hering, whose splendid researches on the minute structure of the liver our readers are familiar with.

Irish Diatomaceæ.—The Rev. E. O'Meara is preparing for the Royal Irish Academy a list of the Irish species. All new species will be figured. Mr. O'Meara has laboured so long and industriously at this department that his work will doubtless be highly prized by microscopists.

Parasitic Fungi on Cereals.—M. E. Fournier has commenced a series of papers on this subject in the 'Revue des Cours Scientifiques.' The first is on the Ergot of Rye.

The Germ Theory.—At the meeting of the Royal Irish Academy on the 9th of May, Dr. Stokes read a paper which showed that putrefaction can take place in closed cavities to which air had not been admitted.

CORRESPONDENCE.

Mr. Stodder's Difficulty about "Acus."

To the Editor of the 'Monthly Microscopical Journal.'

Royal Microscopical Society, King's College,
May 14, 1870.

Dear Sir,—In the last number of the 'Monthly Microscopical Journal,' Mr. Chas. Stodder, in his letter "On the Resolution of Nobert's Nineteenth Band," says, "I do not know what Mr. Powell calls 'Acus' (there is no such genus in Pritchard)." The diatom which is sometimes called *Navicula acus* is described in Pritchard under the name of *Amphipleura pellucida*, Kützing, and must not be confounded with *Navicula acus* of Ehrenberg, which is *Synedra subtilis*, Kützing.

Yours very truly,

Walter W. Reeves.

PROCEEDINGS OF SOCIETIES.*

King's College, *May* 11, 1870.

Rev. J. B. Reade, M.A., F.R.S., President, in the chair.

The minutes of the last meeting were read and confirmed.

It was stated, relative to the question of the alteration of the day of meeting, of which notice had been given by the Council solely with the view of consulting the convenience of the Fellows, that as it had been represented that many of the Fellows had engagements on the first Wednesday in the month which would preclude their attendance at the Society's meetings, the Council proposed to withdraw the motion for the alteration of the 20th Bye-law, which was to have been made that evening. This was done with the consent of the meeting.

A list of donations to the Society was read, and thanks given to the respective donors.

Mr. H. Lee moved a vote of thanks to Mr. C. Stewart, F.L.S., for the trouble he had taken in preparing the catalogue and arranging the objects exhibited at the soirée. The arrangements had been most successfully carried out; and the character of the soirée had been much improved through the display of Mr. Stewart's own splendid collection, as well as by the deep-sea dredgings of Dr. Carpenter.

This vote was unanimously passed.

It was moved and unanimously approved that a vote of thanks be presented to Dr. Carpenter for his very interesting exhibition of objects at the soirée; and also to Mr. Lee, by whom valuable aid had been given.

The President said that soon after his Annual Address had been published a letter had been received from Mr. Hankey, of Chicago, who established the State Microscopical Society of Illinois (to which allusion had been made in the Address), in which that gentleman expressed a strong desire to become a member of the Royal Microscopical Society. He (the President) thought that, considering the high degree of efficiency to which the State Microscopical Society had been brought, it would be but a fitting compliment to pay to Mr. Hankey to propose that his name be added to the list of Honorary Fellows; and he would therefore read the certificate approved of by the Council, and propose that it be suspended till the next meeting, when the election would take place.

The certificate was suspended.

A letter addressed to Mr. Hogg by Colonel Dr. Woodward was read, in which special reference was made to the papers of Dr. Pigott on "High-power Definition." The letter was accompanied by photographs: one of the *Podura* scale magnified 3000 times by Powell and

* Secretaries of Societies will greatly oblige us by writing their reports legibly —especially by printing the technical terms thus: H y d r a—and by "underlining" words, such as specific names, which must be printed in italics. They will thus secure accuracy and enhance the value of their proceedings.—Ed. M. M. J.

Lealand's $\frac{1}{16}$th immersion lens, representing exactly the appearances made so familiar by the drawings of the late Richard Beck; the other representing *P. angulatum*, and particularly remarkable for the roundness with which the dots are brought out.

The following letter was then read to the meeting:—

War Department, Surgeon-General's Office,
Washington, D.C., *April* 23, 1870.

Mr. Jabez Hogg,

Dear Sir,—I have been reading with great interest the papers of Dr. Pigott on the nature of the markings of certain test-objects, and particularly of the Podura scale. The novel views he advances struck me as so interesting that I at once began to re-examine the specimens I had on hand. I must confess that up to the present moment I have been unable to satisfy myself of the correctness of his interpretation of its phenomena; and yet the fact that he appears to have convinced so distinguished a microscopist as the Rev. J. B. Reade, makes me incline to caution in expressing my opinion.

I have had no difficulty in seeing the beaded appearance of the Podura scale which he has described, "green upon a pink ground, or pink upon a greenish ground,"* or greenish blue or blue on a ground of various shades of red or the reverse, with various lenses, especially the $\frac{1}{8}$th of Wales and the immersion $\frac{1}{16}$th of Powell and Lealand, by taking out the condenser and illuminating the scale by a parallel pencil of sunlight reflected by a plane mirror placed somewhat obliquely about 20 inches from the stage. I know, however, of no method of illuminating the microscope more likely to produce interference phenomena, and should have set the appearance down as such without hesitation but for the high authorities to which I have alluded. As just intimated, the colour of the pseudo beads varied from green to blue on the one hand, to pink or deep red on the other; and this appearance appeared to me to depend simply on the degree of colour-correction of the objective used, and corresponded to phenomena observed with the same lens on other objects. Still I do not wish to come to a premature conclusion, and write you with the hope that you can obtain for me from Dr. Pigott two or three slides with scales in which he has seen himself the appearance he has described. I should like to make a careful examination of the matter, but desire to feel sure that I am dealing with scales from the same species of insect, since this has been made such a point.

Since Mr. Pigott has politely alluded to certain photographs of the Podura scale made under my supervision some time ago, I enclose some made by myself since reading his paper, which show what I conceive to be the true appearance of the scale. I should like very much to see a photograph representing Dr. Pigott's views in a manner satisfactory to himself, but fear this is asking too much, unless indeed my distinguished friend Dr. Maddox can be induced to undertake the task. I also enclose a photograph I have just made of the Angulatum scale, which exhibits still more distinctly the structure shown by the

* 'Monthly Microscopical Journal,' December, 1869, p. 300.

photographs, made under my supervision, which I contributed to the Microscopical Society some time since.

Will you not, my dear sir, read this letter and exhibit the accompanying photographs at the next meeting of the Microscopical Society?

I have the honour to be,

Very respectfully,

J. J. Woodward,

Assist.-Surgeon and Brevet Lt.-Col. U.S.A.

Mr. Slack remarked that the effects produced by Dr. Pigott had no connection whatever with the mode of illumination adopted by Dr. Woodward. Dr. Woodward's method of removing the condenser and using the direct light of the sun reflected through the object was objectionable, as it was well known that if a blaze of light is sent into the microscope false appearances are exhibited. Dr. Pigott's mode of illuminating is entirely different. He can show the performance of the finest objective of Powell and Lealand's in the ordinary way; and by introducing an apparatus of his own, for correcting residuary aberration, the definition of known objects is improved, and the beadings of the *Podura* scale are immediately seen. He had spent a long evening with Dr. Pigott, who had performed a number of experiments with lenses which left no doubt on his (Mr. Slack's) mind that the best of them produce spherical aberrations.

A very striking experiment was made by converting the microscope into a telescope, and viewing with the objective to be tested artificial double stars ingeniously contrived by Dr. Pigott, and consisting of minute discs of light, the diameters and interspaces of which were both known. A badly-corrected glass would not divide them at all, and a well-corrected glass of Powell and Lealand's, which just divided them, gave smaller discs and larger interspaces—thus coming much nearer true definition—when Dr. Pigott's correcting apparatus was introduced.

Mr. J. Beck inquired whether Dr. Pigott had used a simple globule of quicksilver in order to correct the faults that arise from spherical aberration, and whether in his method of illumination either outward or inward coma was apparent; and also whether the rings of light expand evenly, or whether they expand on one side of the focus only.

Mr. Slack said that Dr. Pigott had used globules of mercury, but did not consider them so severe a test as others he had devised; as it was well known to mathematicians that these globules were not perfectly spherical, and they were not illuminated by direct light.

The President wished to confirm Mr. Slack's observations upon Dr. Pigott's discoveries. In answer to Mr. Beck, he stated that Dr. Pigott does show bright points of light in concentric rings on both sides of the focus. Other experiments clearly prove that he does very materially diminish spherical aberration. The flame of a lamp, for instance, under a really good object-glass, is seen to be surrounded with a halo of light; but as soon as the "aplanatic searcher" is introduced by Dr. Pigott between the eye-piece and the object-glass, the image is as clear, bright, and definite as when the flame is seen with the naked eye. This he considered a very satisfactory proof of the diminution of spherical aberration. It was known that he (the President) doubted at first the accuracy of Dr. Pigott's interpretation of the *Podura* scale; and that he could not feel perfectly convinced until he had satisfied himself that the representations were those of the true test-scale, by examining some of his own test-objects by Dr. Pigott's method. He now, however, believed that Dr. Pigott had conclusively proved that the beads so distinctly visible under Dr. Pigott's arrangement are characteristics of the scale. He (the President) thought that the method of illumination employed by Dr. Woodward could hardly lead to a correct representation, as had been stated by Mr. Slack. Dr. Pigott's whole arrangement is totally different, and leaves the impression on the mind that what the eye has seen does in reality exist.

Mr. Beck said the remark made with regard to the want of true sphericity in globules of mercury had no force as against his advocacy of their use for correcting aberration. The value of the test consisted in the ease with which a simple globule could be separated into minuter globules, each of which had the capacity of reflecting a point of light.

The President said that small points of light used by Dr. Pigott were equivalent to small globules of quicksilver.

Mr. Lee then read a paper of Dr. Bowerbank's, of which notice had been given at the previous meeting.

The thanks of the meeting were presented to Dr. Bowerbank.

Mr. Holmes then read a paper describing an invention of his own, by which, through the use of two object-glasses, or two halves of object-glasses, a binocular and stereoscopic view of opaque and transparent objects can be obtained; and also a means of producing, by certain mechanical appliances, such motion of the optical parts of the instrument, and such combinations, as shall secure at the will of the operator either binocular or monocular vision.

After some time had been devoted to the examination of the instruments exhibited by Mr. Holmes, Mr. Brooke said he thought that it would be a matter of extreme difficulty to obtain the necessary accuracy of centering with halves of lenses only, and that it would be impossible with high powers, say with anything above ¼-inch, with halves of lenses only to give a good definition.

Mr. Slack believed that Mr. Holmes had greatly exaggerated the defects of definition with the Wenham prisms. A first-rate instrument showed difficult test-objects nearly as well when the prism was used as without it. It also appeared to him that optical errors of diffraction must be introduced by the plan of using halves of lenses. He doubted the possibility of effecting the perfect division and centering of high powers.

After some further discussion on this subject, the President said that it appeared to be the general impression that Mr. Holmes had produced an instrument capable of giving a perfectly stereoscopic view of an object, but that the definition was faulty, which was excusable in amateur work. There could be no doubt that the mechanical arrangements were most admirable.

The President also stated that before he adjourned the meeting he wished to allude to the statement in his *Address* that Dr. Woodward was the *only observer* who had succeeded in resolving Nobert's 19th band, containing 112,688 lines to the inch, with a power of 1000 linear. Mr. Charles Stodder, of Boston, had however preceded Dr. Woodward in resolving this band, as appears in the 'Monthly Microscopical Journal' for May. In this letter Mr. Stodder has directed our attention to a paper from himself, "On Nobert's Test-Plate," published in the 'Quarterly Journal of Microscopical Science' for July, 1868. This paper having been published in our vacation had been overlooked, otherwise he (the President) would have gladly relieved Mr. Stodder's mind from any suspicion of unfair dealing by giving the following quotation:—"With Tolles' $\frac{1}{6}$th immersion, angular aperture 170°, B eye-piece, power 550, Mr. Greenleaf and myself both saw the 19th band satisfactorily. Thus being probably the first ever to see lines of 112,000 to the inch, and establishing the fact of the visibility of such lines, contrary to the theory of the physicists." Hereby Mr. Stodder, as well as Dr. Woodward, had supplied "a strong fact in favour of the immersion system," which was the real point in question; though at the same time it should be borne in mind that Colonel Woodward in his communication to the Society had thrown some doubt as to the nature of the lines *seen* but *not counted* by Mr. Stodder. The President added that Mr. Stodder seemed to have forgotten that Messrs. Harrison and Sollett, of Hull, were the first to discover and describe the *Navicula acus*, which has made "the acus" a familiar term in England.

The meeting then adjourned to June 8th, when Mr. J. W. Stephenson, F.R.A.S., will exhibit and describe a New Form of Binocular Microscope, and Mr. James Bell, of the Laboratory, Somerset House, will read a paper, "Experiments on Fermentation and Parasitic Fungi."

Donations to the Library from April 13th to May 11th, 1870:—

	From
Land and Water. Weekly	*Editor.*
Society of Arts Journal. Weekly	*Society.*
Nature. Weekly	*Editor.*
Scientific Opinion. Part XVIII.	*Editor.*
Set of Proof Impressions from the Plates illustrating Mr. Suffolk's Lectures to the Quekett Club	*W. T. Suffolk, Esq.*

The following gentlemen were elected Fellows of the Society:—

John Graham Berry, Esq.
Rev. Charles Burrows.

Walter W. Reeves,
Assist.-Secretary.

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Recherches sur le Système latéral du Nerf pneumogastrique des Poissons. Résumé d'Anatomie. Par le Docteur J. S. Fort, Professeur libre d'Anatomie. Avec 73 figures dans le texte. Paris. Delahaye.

Nouveaux Eléments de Botanique, contenant l'Organographie, l'Anatomie, la Physiologie végétale et les Caractères de toutes les Familles naturelles. Par Achille Richard. Paris. Savy.

Mémoires de la Société Linéenne du Nord de la France. Amiens. Lenoel Hérouart.

Recherches sur les Crustaces d'eau douce de Belgique. Par M. F. Plateau. II^e. et III^e. parties. Bruxelles.

Matériaux pour la faune Belge: Crustaces isopodes terrestres. Par M. F. Plateau. Bruxelles.

Die Stammverwandtschaft zwischen Ascidien und Wirbelthieren. Nach Untersuchungen uëber die Entwicklung der Ascidia canina von Herrn C. Kupffer. Bonn Cohen & Sohn.

Handbuch der pathologischen Anatomie von Herrn E. Klebs. Berlin. Hirschwald.

Untersuchungen aus dem Institute für Physiologie und Histologie in Graz. Herausgegeben von A. Rollet. Leipzig. Engelmann.

Das Wachstum der Pflanzen von Herrn J. Knott. Landshut. Thoman.

Urber den Ursprung und die Vermehrung der Bacterien. Von Herrn S. Polotebnow. Wien. Gerold's Sohn.

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