# JOURNAL

OF THE

# ROYAL MICROSCOPICAL SOCIETY;

CONTAINING ITS TRANSACTIONS AND PROCEEDINGS

AND A SUMMARY OF CURRENT RESEARCHES RELATING TO

ZOOLOGY AND BOTANY

(principally Invertebrata and Cryptogamia),

MICROSCOPY, &c.



---

*Edited by*

**FRANK CRISP, LL.B., B.A.,**

*One of the Secretaries of the Society*
*and a Vice-President and Treasurer of the Linnean Society of London ;*

WITH THE ASSISTANCE OF THE PUBLICATION COMMITTEE AND

A. W. BENNETT, M.A., B.Sc., *Lecturer on Botany at St. Thomas's Hospital,*
F. JEFFREY BELL, M.A., *Professor of Comparative Anatomy in King's College,*

S. O. RIDLEY, M.A., *of the British Museum*, AND JOHN MAYALL, JUN.,
FELLOWS OF THE SOCIETY.

—— .—VOL. III. Part II

PUBLISHED FOR THE SOCIETY BY
WILLIAMS & NORGATE,
LONDON AND EDINBURGH.
1883

BI-MONTHLY.
Vol. III. No. 4.] AUGUST, 1880. [To Non-Fellows, Price 4s.

# JOURNAL

OF THE

# ROYAL MICROSCOPICAL SOCIETY;

CONTAINING ITS TRANSACTIONS AND PROCEEDINGS,

AND A RECORD OF CURRENT RESEARCHES RELATING TO

**INVERTEBRATA, CRYPTOGAMIA, MICROSCOPY, &c.**

---

*Edited, under the direction of the Publication Committee, by*
FRANK CRISP, LL.B., B.A., F.L.S.,
*One of the Secretaries of the Society;*

WITH THE ASSISTANCE OF

A. W. BENNETT, M.A., B.Sc.,
*Lecturer on Botany at St. Thomas's Hospital,*

F. JEFFREY BELL, M.A.,
*Professor of Comparative Anatomy in King's College,*

AND

S. O. RIDLEY, B.A., F.L.S.,
*Of the British Museum,*

FELLOWS OF THE SOCIETY.

Vol-III = Part 2

WILLIAMS & NORGATE,
LONDON AND EDINBURGH.

PRINTED BY WM. CLOWES AND SONS, LIMITED,] [STAMFORD STREET AND CHARING CROSS.

THE JOURNAL is published at the end of the first week of the month.

JOURNAL

OF THE

ROYAL MICROSCOPICAL SOCIETY.

VOL. III. No. 4.

# CONTENTS.

Record of Current Researches, &c.—*continued.*

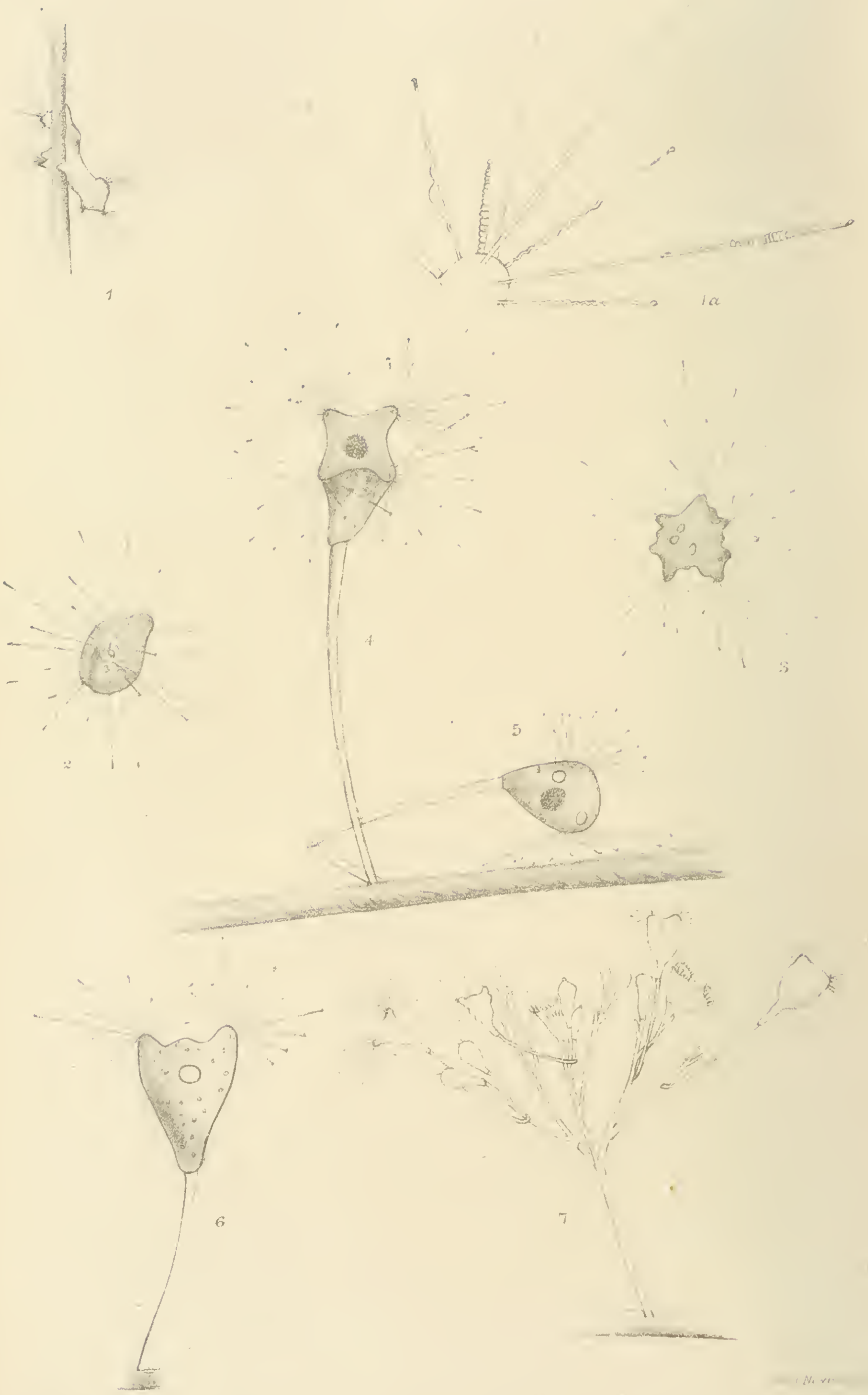


Botany.

Record of Current Researches, &c.—*continued.*



Microscopy.




Acinetina, Trichophrya epistylidis & Podophrya quadripartita

# JOURNAL

OF THE

# ROYAL MICROSCOPICAL SOCIETY.

AUGUST, 1880.

## TRANSACTIONS OF THE SOCIETY.

### XVI.—*Notes on Acinetina: Trichophrya epistylidis, and Podophrya quadripartita.* By John Badcock, F.R.M.S.

(*Read 10th March*, 1880.)

Plate XIV.

Early in November 1879 I found on some filamentous Algæ in one of the ponds in Victoria Park, a curious amœboid form of what seemed to be an Acineton, and which I subsequently found had been originally discovered by MM. Claparède and Lachmann, and named *Trichophrya epistylidis*. They found it parasitic on the *Epistylis*, and being struck with its singular character, considered it entitled to rank as a new genus under the above name. They give a somewhat brief account of it. It is, however, very singular that those authors should have *contrasted* this form with *Podophrya quadripartita* (originally discovered by Baker, and subsequently found by Stein). Stein had argued in favour of the theory of the *Acineta**-state in the life-history of many of the Infusoria, and among others had described *P. quadripartita* as the *Acineta* of *Epistylis plicatilis*, because they were generally found together, and Claparède and Lachmann say that for the same reason *T. epistylidis* might be inferred to be similarly related to the *Epistylis*, for "The one, like the other, seems in effect to lead the life of a parasite, almost exclusively on the branches of *Epistylis*."

It would be a curious commentary on the disputes of those high authorities on these matters if it could be shown that *Trichophrya epistylidis* and *Podophrya quadripartita* are one and the same species in different stages, and that *Epistylis* has nothing to do with either. Such I believe to be the case, as the following observations will show, if not conclusively, yet as probable in the highest degree.

I do not think that the identity of the organism which I found

* This theory has since been abandoned by Stein.

(Pl. XIV., Fig. 1) with those of Claparède and Lachmann will be disputed, as both the figures and descriptions prove it, with one or two exceptions which are not essential. Thus, as to parasitism, I did not find mine on the *Epistylis*, but on filamentous algæ: neither have I seen the faint outline of any embryo as described by them.

Having placed my first find in a small zoophyte trough, for the purpose of daily watching it, I soon noticed that the sides of the glass were covered with very much smaller bodies than those on the algæ, and, though having the same *Acineta*-like character, were much more varied in form as well as being very transparent (see Figs. 2, 2*a*, and 3). These were very interesting objects of observation, as one could plainly see the contractile vesicles, the suctorial character of the tentacles, and their slowly spiral movement of protrusion and retraction. They were not of slow growth, but came suddenly as though a vesicle or similar body had been ruptured and its contents shot forth, which coming in contact with the glass would produce just the appearance noted. The contractile vesicles were similarly irregular, both as to position and number. In fact, it was impossible to find any two bodies alike in shape or organic differentiation. Only one common character pervaded them, they were all bright, shining patches, semi-fluid, transparent, and acinetiform.

As the winter advanced the pseudopodia or tentacles disappeared, and also the contractile vesicles and other signs of active life, leaving only small lumps and patches of what may be called protoplasm. These had nothing of the appearance which death produces. They were simply bits of quiescent matter, looking more like shining crystals than anything else.

I had not expected to be able to make any further observations until another season, when the following incident attracted my attention. I had given some of the algæ to my friend Mr. Cocks, with the animal forms on it in abundance, which he placed in his aquarium. This he has recently found to be covered with the very beautiful forms represented in Figs. 4 and 5, or in other words by *Podophrya quadripartita*. On seeing these at first, and taking note of similarity in some points notwithstanding differences in others, my suspicions as to their being the same were materially strengthened, if not confirmed, by comparison with one form which I had drawn last November (Fig. 6). This was found with the others, but not presenting the same special appearance, I had not considered it in its true character; and my view now is, that as in all forms of life some few more vigorous, or favoured by other circumstances, will remain after the majority have passed away, so these solitary individuals remained. There can be no doubt, I think, of the identity with Figs. 4 and 5.

This being so, Nos. 1, 1*a*, 2, and 3, are the immature stages in the life-history of the perfect form now recognized as *Podophrya quadripartita;* and consequently the new genus *Trichophrya* of Claparède and Lachmann must be abandoned.

One of the forms here figured illustrates the so-called *Acineta* of *Epistylis*. Fig. 7 is the *Epistylis* with the *Acineta* here and there upon its branches, and on first observing it under the Microscope with Mr. Cocks we were inclined to think it a confirmation of Stein's theory, when my son, whom we had asked to sketch it, remarked that it was not a portion of the *Epistylis*, but only attached to it. It was somewhat difficult to see the attachment, however, but we were confirmed as to its nature by subsequently seeing it on *Carchesium* and *Ophrydium*, as well as by its abnormal position on the sides of the branches of *Epistylis*.

Since writing the foregoing I have been able to make some further observations of an interesting nature, which I will briefly state.

I have traced the life-history of one form with tolerable clearness. I had often noticed several small round ciliated bodies moving about the field of view, sometimes rapidly spinning round, and then springing with a jerking bound from place to place. On pursuing one of these bodies it was found finally to settle down on a filament of the alga, and gradually to develop a peduncle; then the ciliate character simultaneously changed to that of the *Acineta*, and finally it gradually branched out to the three- or four-cornered perfect form of *Podophrya quadripartita*.*

These ciliated forms correspond to the description usually given to *Megatricha partita*, and in their further development—attached and with a pedicle—to *Podophrya fixa*. Further I have observed that in the *Megatricha*-state they multiply by self-division. May we hazard the inference, in view of these observations, that as not only these, but many other similar forms of life, pass through several life-cycles, in each of which they "increase and multiply," this peculiarity has been the fruitful cause of numberless new genera and species having been too hastily adopted?

* This I have seen in many instances since, and found them to develop on the glass as well as on the weed.

## XVII.—*On the Visibility of Minute Objects mounted in Phosphorus, Solution of Sulphur, Bisulphide of Carbon, and other Media.* By J. W. Stephenson, Treasurer R.M.S., F.R.A.S.

(*Read 9th June*, 1880.)

The theory that there is a "loss of aperture on balsam-mounted objects" was enunciated more than twenty years ago by more than one writer, and although never accepted without question, it has been maintained with more or less frequency until a comparatively recent date, when Professor Abbe's demonstration of the theory of microscopic vision rendered it absolutely untenable.

It is not only untrue that there is a loss of aperture under such circumstances, but it is positively the reverse of the truth in every case in which it produces any effect whatever.

It has already been pointed out in the Society's Journal,* how this mistaken notion probably arose, viz. by failing to distinguish between a diminution of *angle* (which of course takes place in the case of balsam-mounted objects) and a diminution of *aperture*, two entirely different matters, as a *small* angle in one medium (as oil) may be capable of embracing more diffraction spectra than a *large* angle in another medium (as air), the small *angle* having in fact the larger *aperture* and *vice versâ.*

The loss of aperture by transmitted light is therefore on objects *mounted in air*, and this can only be prevented by mounting in balsam, or some other medium which has a refractive index equal to, or greater than, the numerical aperture of the immersion objective employed.

This loss from "dry mounting," as it is called, arises in all objectives which have an equivalent angle exceeding 180°, which is the case with so many of the modern immersion objectives, and notably so in those on the homogeneous principle.

It is this fact which has induced me to bring the subject of mounting in different media before the Society this evening, as it is obviously of little use to obtain objectives of the large apertures with which we are now familiar, if by employing them on objects surrounded by air we reduce their effectiveness to the common level of 180° (= 1 n. a.).

I have said "surrounded by air" because when an object is in physical contact with the cover, the loss is, by its adhesion on *one* side, reduced to one-half, just as in an object mounted in balsam the whole aperture is preserved by the contact of *both* its sides with the medium in which it is mounted.

But in mounting diatoms (and some other objects) in Canada balsam, we find that although we have secured the full aperture of

* See this Journal, ii. (1879) p. 774.

the objective, and therefore its full resolving power, we have done so at the expense of the visibility of the resultant image, which has become fainter by the nearer approximation to equality of the refractive indices of the diatomaceous silex and the Canada balsam in which the object is mounted; the markings, whatever they may be, are less pronounced than they would have been in air had the structure been sufficiently coarse for resolution in that medium, a result which Professor Abbe has shown to be attributable to the paler diffraction spectra yielded by the balsam-mounted object—hence we see that it may be possible to resolve an object in balsam which would be impossible in air, but that if resolvable in *both* it would be *more visible* in air than in balsam.

It may be demonstrated that the visibility of very minute structures is *proportional* to the *difference* between the refractive indices of the object and the medium in which it is mounted $(n - n_1)$.

It follows from this that when this difference $= 0$, or is very small, the structure is invisible. This is the case, as most of us know, when diatoms are immersed in strong sulphuric acid, and it may therefore be inferred, as was pointed out some years ago, that the refractive index of diatomaceous silex is about 1·43, which, without any pretence that it is exact, I shall assume as its true value in the following observations.

As the visibility of minute structures is proportional to the difference between the refractive indices of object and medium, it is necessary to give a short table of the refractive indices of those substances to which I shall refer, and from which the *differences* of the indices are to be deduced.

Table of Indices.

| | |
|---|---|
| Air .. .. .. .. .. .. .. .. .. .. .. .. .. .. | = 1 |
| Water .. .. .. .. .. .. .. .. .. .. .. .. .. | = 1·33 |
| Diatomaceous silex and sulphuric acid .. .. .. .. .. .. | = 1·43 |
| Canada balsam .. .. .. .. .. .. .. .. .. .. .. | = 1·54 |
| Bisulphide of carbon .. .. .. .. .. .. .. .. .. .. | = 1·68 |
| Solution of sulphur in bisulphide of carbon (approximately) .. | = 1·75 |
| Sulphur .. .. .. .. .. .. .. .. .. .. .. .. .. | = 2·11 |
| Solution of phosphorus in bisulphide of carbon (approximately) | = 2·10 |

The first case we will consider is that of the visibility of a diatom in air, which, although it is otherwise excluded from consideration in consequence of the loss of aperture involved, is nevertheless valuable as a standard of comparison.

The index of diatomaceous silex being taken as 1·43, and that of air being 1, we have as a measure of the visibility of a fine diatom in *air* the number ·43.

Taking now the various media in succession, and commencing with water, of which the index is 1·33, the index of diatomaceous silex being, as before, 1·43, the difference, being the measure of visibility of a diatom in *water*, is represented by ·10.

The next in order is Canada balsam, with its index of 1·54; deducting the index of silex, 1·43, we obtain the difference of ·11, which is the measure of visibility of the same object in *balsam*, and almost identical with that of water.

The next in succession is bisulphide of carbon,* index 1·68, diatomaceous silex 1·43, giving as the measure of visibility in *bisulphide of carbon* ·25, which it will be observed is about two and a half times as great as that obtainable in water or balsam.

This result may however be exceeded by dissolving sulphur in the bisulphide of carbon, although to what extent I am unable at this moment to say, but as sulphur has an index of 2·115, and is moderately soluble, I think I am safe in assuming that the index of the solution is 1·75; deducting from this 1·43, we obtain ·32 as the measure of visibility in solution of *sulphur*, which is nearly three times as great as that of balsam.

The last in the list is phosphorus, but as this, from its crystalline character, cannot be conveniently used in its solid form, it is also dissolved in bisulphide of carbon, the solution being just short of that point at which crystals appear.

From the extreme inflammability of phosphorus and other difficulties it is very improbable that it will ever be used to any great extent, although there is to my mind great scientific interest in the experiment.

If we take the solution of phosphorus as having an index of 2·1, and deduct that of the silex, 1·43, we obtain ·67 as the measure of the visibility of fine diatom markings in solution of *phosphorus*, which is six times as great as that of the same object in balsam, and no less than 50 per cent. higher than its visibility in air itself—whilst the greater brightness of the diffraction spectra will make the more refrangible rays effective, and thus give a greater power of *visual* (as distinguished from *photographic*) resolution.

Summarized we get the following results:—

Table showing the Visibility of Fine Diatoms when Mounted in the following Media, securing the full Aperture of Objective.

| | |
|---|---|
| Water .. .. .. .. .. .. .. .. .. .. | 10 |
| Canada balsam .. .. .. .. .. .. .. .. | 11 |
| Bisulphide of carbon .. .. .. .. .. .. .. | 25 |
| Solution of sulphur in bisulphide of carbon .. | 32 |
| Solution of phosphorus in bisulphide of carbon .. | 67 |

The practical result of the investigation appears to be that it is essential, if the whole aperture of an objective is to be utilized, to mount minute structures in some medium other than air.

* Oil of cassia gives almost exactly the same result.

That although the full aperture and resolving power are secured by mounting in balsam, it gives nevertheless nearly the faintest image of all.

That a solution of phosphorus is, as far as visibility is concerned, by far the most effective, but the difficulties attending its use must render it unpopular.

The next best is a solution of sulphur in bisulphide of carbon (although pure bisulphide is very good), and with these there is no technical difficulty whatever.

A ring of the aqueous solution used by Mr. Browning in making his bisulphide prisms being formed on the slip, and a drop of the sulphur solution or pure bisulphide being placed in its centre, nothing is necessary but to place over it the thin cover with its adhering diatoms, press it down on the still moist ring, running round it a somewhat copious margin of the cement, and the thing is done.

In a short time the glutinous cement sets and finally becomes dry, when, in order to protect it from the water of the ordinary immersion lenses, it is desirable to give it a coat of gold size, or shellac varnish, although for mere keeping purposes this is unnecessary.

The same course may be adopted in mounting in phosphorus, except that the solution must be run in from the edge of the thin cover to avoid the phosphoric acid which rapidly forms on its surface, and destroys the effect wherever it comes in contact with the object. I have found varnish made of the best red sealing-wax (which is better than pure shellac) as useful as Browning's aqueous cement above referred to, but as it is brittle when dry it should also be protected by a coating of gold size.

There are now on the table objects mounted in phosphorus and bisulphide of carbon, which I exhibited in 1873,* and they still remain unchanged notwithstanding the volatile nature of the materials. On that occasion I fell into the error of saying that there was a loss of aperture (instead of angle) with *dry* objectives on objects mounted in phosphorus and bisulphide of carbon, when in fact the aperture remained unchanged.

* See 'Mon. Micr. Journ.,' x. (1873) p. 1.

## XVIII.—*On the Development and Retrogression of Blood-vessels.*

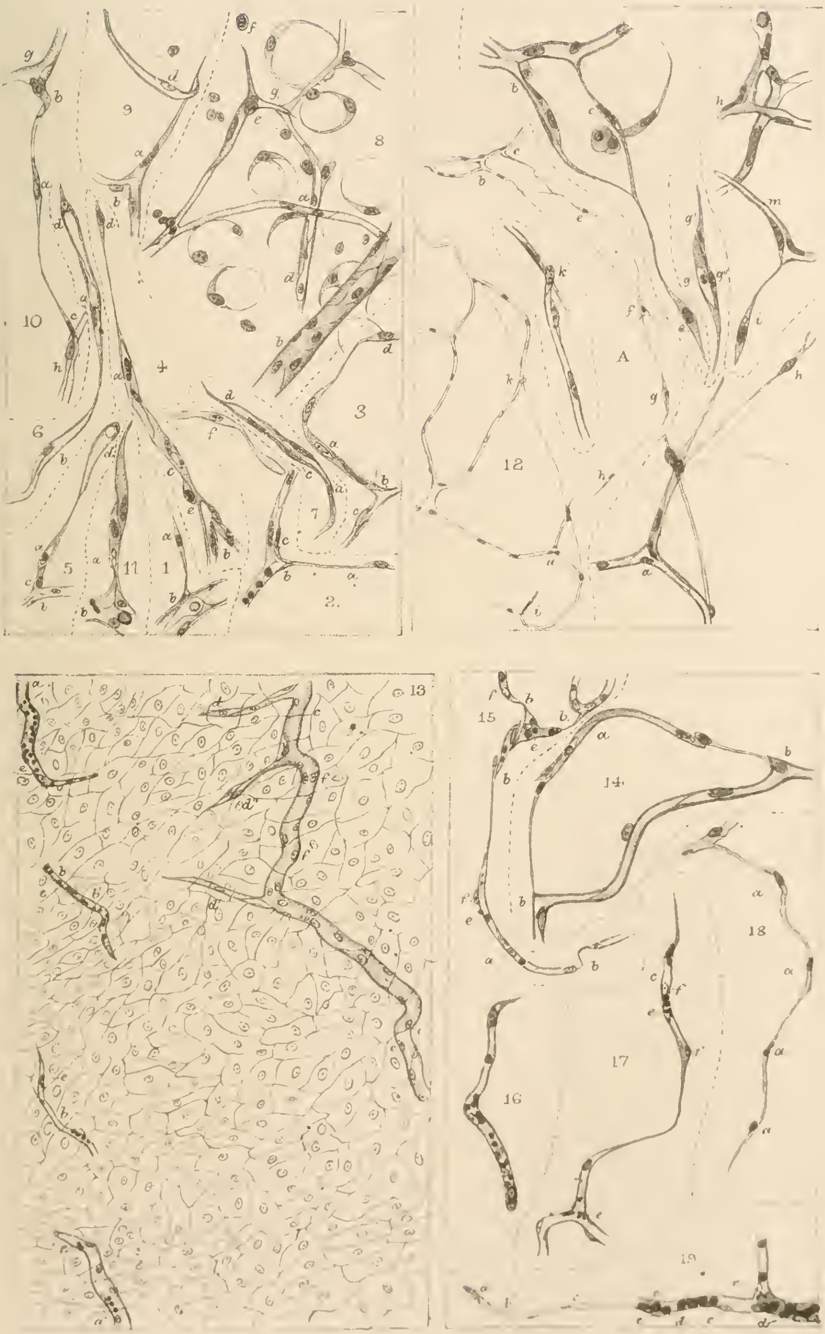
By George Hoggan, M.B., and Frances Elizabeth Hoggan, M.D.

(*Read* 14*th April*, 1880.)

Plate XV.

At the present day it is not necessary to hold pessimist ideas in histology in order to admit that our knowledge of the manner in which blood-vessels are formed is still unsatisfactory; and although for the last thirty years the most eminent histologists have sought to elucidate the question, it may fairly be said that the very latest opinions enunciated, differing as they do from all previous ones, are in no way more satisfactory. Although many of these opinions appear diametrically opposed to each other, they are principally so, it seems to us, in being too exclusive in their application; and with the view of reconciling them, we desire to put on record a series of clearly ascertained facts or appearances which certain new histological processes devised by ourselves have enabled us to obtain.

In our opinion, the general disagreement among histologists upon this question is caused, in the first place, by the unsuitability of the tissues in which it has been studied, and in the second place, by the mode of preparation employed. Paradoxical though it may appear, we have learnt from experience that the worst place in which to study the development of any special tissue is the embryo itself. There the embryonic cells are so little differentiated from each other in shape, the intercellular substance or matrix is so extremely scanty, while the process of developmental growth is so rapid, that it is almost impossible to obtain a clear demonstration. The membranous expansion of the tail of a living tadpole, which has been so often employed for this kind of research, and from which so diametrically opposed views have been deduced, is especially unsatisfactory, because in the living cell no nucleus is visible, and the polar star of the histological explorer being invisible, all true ideas of direction and course of development are naturally enough shrouded in obscurity. For our part, we have found nothing so suitable as the growing broad ligament of pregnant rats and mice, more especially during a first pregnancy, for there we have a fringe of developing capillaries lying in a thin, rapidly distending membrane, in which the gelatinous matrix is so plentiful and clear that every vessel-forming cell stands out in distinct relief. In that membrane, moreover, the silver method of fixing and marking can be applied most favourably, in order to show the junctions of the cells forming, or about to form, the blood-vessels, in the position and shape they possessed when alive.




G. Hoggan del.

Development & Retrogression of Blood-vessels

The animal (by preference a house mouse) ought to be only moderately well nourished, as both extremes of nutrition defeat our object, either by obscuring the developing vessels by fat-cells, or preventing the vessels from being formed. It ought first to be gently anæsthetized by chloroform under a jar, and as soon as it is insensible, it ought to be drenched with the anæsthetic, and then left to die. We never lose time by injecting the animal and afterwards allowing it to cool, as by that process not only do the cells alter in shape, but the injection interposes an annoying obstacle to vision when it has filled the vessels.

As soon as it is dead, we open up the abdomen along the linea alba, so as to completely expose the gravid uterus, and then seizing the uterus of one side with fine pointed forceps, we raise it out of the body cavity, so as gently to distend the membrane or broad ligament which attaches it to the abdominal wall. On one side of this membrane we place the smaller of a pair of the histological rings invented by us, and already described in this Journal;* and without allowing it to glide or rub over the surface, we place the larger of the two rings upon the smaller. In this way a miniature tambourine is formed; and after the two rings have been carefully jammed one on the other, by a slight circular movement, the excess of membrane can be snipped off external to the rings, and a one-half per cent. solution of silver in distilled water poured upon either or both surfaces, without preliminary washing; but after a few minutes exposure to a dull light, the whole may be gently washed with ordinary water.

In our piece of membrane not only are the cells fixed in their living shape, but, as the blood-vessels were full of blood when the one ring was jammed upon the other, the distending blood was thus retained within them, and the silver solution now fixes them in this condition, and makes also the outlines of the cells, which alone form them, distinctly visible. The membrane is now ready for staining, the best of all methods for this purpose, according to our experience, being the one invented and published by one of us. By this method the membranous portion of the tambourine is first soaked for a few minutes in methylated spirit, a teaspoonful in a watch-glass or small saucer being sufficient. This is then poured away, and in its stead a few drops of a 2 per cent. solution of perchloride of iron in spirit is filtered upon the membrane. After a few minutes a 2 per cent. solution of pyrogallic acid in spirit is next filtered upon it, and allowed to remain there from a few seconds to a few minutes, according to the depth of tint required, and then the whole is well washed with ordinary water, and the staining process is complete. A few drops of glycerine may then be placed upon the membrane to clarify it, and the preparation

* See vol. ii. (1879) p. 357.

may be studied at once under the Microscope, or mounted on a slide as a permanent preparation.

It may with equal facility be rendered transparent by alcohol and an essential oil, and mounted in balsam or copal varnish, but it then possesses all the disadvantages of a balsam preparation. Under all circumstances, the membrane must be clarified before it is excised from the rings, to prevent unequal contraction. It is easily excised by running the edge of a knife round the outer rim of the inner ring, and having prepared a slide previously with a drop of glycerine upon it, the disk of membrane remains in place when applied to it; the glass cover may then be put on and sealed, as we do it, by hot sealing-wax dropped round the edges, and trimmed with a hot wire while the whole is compressed by a paper-clip.

We have thus a preparation mounted in glycerine, in which no undue distension has taken place, to whose surface no injury has been done during the whole course of preparation, and whose progress at every stage could be examined under the Microscope without damaging it. Moreover, when mounted in glycerine the blood leaves the vessels when the disk is excised, and is washed away at the edges with the excess of glycerine, so that all the vessels appear as rigid, hollow tubes, the thickness of whose walls and the joints and nuclei of the cells composing them, can be equally well seen by the silver and pyrogallate of iron processes we have used.

As an admirable little review of the opinions already arrived at by different observers on the question of the development of blood-vessels, has lately been given by Dr. George Thin in 'The Quarterly Journal of Microscopical Science' for July, 1876, we think it inadvisable to lengthen out this paper by any recapitulation of them. With regard to even the latest views, Dr. Thin states:—"The conclusion to which I have therefore come is, that the cellules vasoformatives of Ranvier are spaces in the omentum, to which, I submit, the term 'cell' is not applicable. The development of blood-vessels takes place by an escape, first of fluid, and finally of the formed elements of the blood from the vascular system into these spaces. The establishment of the blood current is speedily followed by the formation of a membranous wall around the current, which is impermeable for an injection mass or the blood, and the process is complete."

We are careful to give Dr. Thin's views in his own words, as they are the latest, to our knowledge, which have appeared in English. They are opposed to the views of all previous observers, and they are equally opposed to all the facts we have ascertained and are about to state in this paper. Indeed we fail to understand how, if he has used the silver process, he has overlooked the fact that portions of capillaries show the junction markings of the hollow cells composing them, *before ever they have become connected with the circulation.*

We have found that a new development of blood-vessels takes place solely by the aid and addition of the wandering cells.* In the membranous sheet under consideration, the only cells present, apart from the layers of endothelium covering the two surfaces of the rapidly growing tissue, are the wandering cells. They may be seen here in at least three conditions. They may be found wandering purposeless over the free surface of either layer of endothelium, or through the soft gelatinous matrix forming the membrane between these layers. If the tissue has been properly prepared, they are generally found branched in the latter locality, although on the free surfaces they have retracted into a globular or circular form, being surrounded by no matrix to retain them in the branched condition when the silver is applied to fix them. If the animal has been injected and left to cool before it is opened, and the silver solution be then applied, they will probably appear round in shape within the matrix, and very plentiful on the free surfaces in the same form; or they may be found developing into fat-cells in the neighbourhood of the blood-vessels, in which condition they may either appear round or with *many* branches, according to the conditions of preparation already referred to. They may have more than one nucleus in the purely wandering condition, but they have not more than one nucleus as a rule when developing into a fat-cell. Again, they may be found placing or having placed themselves in position to form or to strengthen a blood-vessel in course of development. The methodical manner in which this is effected would almost argue an instinct or intelligence worthy of higher animals; and although the directions the cells move in when forming the new vessel may be manifold, they seem to follow a regular course throughout. They may either plant themselves at a point in a blood-vessel where a connection is to be formed, and prolong their protoplasmic cell substance to join hands with another cell link in the chain of capillary development, as at *a*, Fig. 9 (Plate XV.), and *e*, Fig. 8, or, as is more common, they may appear external to the future point of junction, and, stretching towards it their protoplasmic arm, thus complete the connection. This peripheral position may be either in direct linear continuation of a new vessel, as at *d*,

* We think it unnecessary that we should again enter at any length into the reasons we have already given in our former article on the Fat-cell, for rejecting the hypothesis that the fixed cells of the connective tissue have any share in the formation of blood-vessels, fat-cells, &c. We cannot admit that any fixed cell of any tissue can normally develop directly into the fixed cell of any other tissue. A cancer cell may indeed impress its character upon any fixed or embryonic cells near it, so that these also become cancer cells; but, normally, fixed cells can only arise from or return to embryonic cells.

Figs. 4, 5, and 6, or at right angles to it, as at *a*, Figs. 1 and 2, and *i*, Fig. 12. Strange to say, in the latter condition the already existing blood-vessel or capillary seems always ready to meet such an advance half-way, and will either bend its whole tube, in the case of a capillary, or dimple its cellular wall, in the case of a larger blood-vessel, towards the vessel-forming cell, as seen in the examples last named.

It is also worthy of notice that, when we examine the membrane in the vicinity of such a cell, we find that no other cell is as yet in position to continue the process of development; that, in short, the solitary vessel-forming cell has specially come to place itself in the most favourable position to enter into the continuation of the vessel peripherally, and acts there until another cell may come and place itself beyond it to continue the process. But the most wonderful instinct of all is seen when a large capillary loop is about to be formed, when several cells are seen placing themselves at considerable distances from each other in the precise line which the future vessel is to occupy. This is well seen in Fig. 12, A, which shows under a power of 100 diameters a plan of such a loop about to be formed between *a* and *b*, the nodal points in already formed capillaries, where attachments to the circulation are to be formed. In this loop or chain, independently of the cells at *a*, *b*, and *c* already attached to the capillaries (all the component cells of this chain are drawn separately in the same figure at a much higher power) we have four links formed, three of them consisting as yet of only single cells *e*, *f*, and *h*, and one link *g*, consisting of three cells, two of which are already vacuolating or hollowing out to form a tube before any connection is made with the comparatively distant blood-vessels. Indeed this, the most advanced link of the chain, is almost equidistant from the nodal points of junction at *a* and *b*. It will also be observed that while $g\,g'$, the cells which specially hollow out to form the tube, join by overlapping their ends, or, in other words, by forming a splice, the third cell $g''$ places itself upon the splice or junction of the cells, and therefore at the weakest point, by way of strengthening the whole. This splicing of cells and application at the point of junction of strengthening cells we have found invariably throughout, as will be seen also in all the other figures. Another point of interest at this spot is the position or presence of a fibre or fibres which seem to connect the cells together and with the nodal points, or, in other words, to mark out the line of the future vessel.

Let us next consider the action or behaviour of a single cell when about to develop into a blood-vessel, and let us choose, in the first place, a single cell joining itself at right angles to an existing blood-vessel or capillary from what *seems* to be a peripheral direction; but while we say seems, we do not wish to say that such is the actual condition, as will afterwards appear. For convenience' sake, let us commence with Fig. 1, where we see a spindle-shaped or bipolar cell, *a*, forming a junction with a comparatively large blood-vessel *b*. We speak of cell *a* as bipolar, because it has stretched out one-half of its protoplasm peripherally on one side, while the other half is stretched out centrally in connection with the blood-vessel. We may also note here that whatever shape a wandering cell may possess before it makes up its mind to enter into the composition of a blood-vessel, no sooner is that settled than it assumes the elongated form, being either unipolar or bipolar from the nucleus, and in no case yet have we seen a many-branched or stellate cell entering into connection with a developing blood-vessel. In Fig. 1 we also notice that the wall of the blood-vessel is bulged out at its attachment to the protoplasm of the peripheral vessel-forming cell, *a*, and the question is an open one whether the bulging is the result of sympathy on the part of the vessel towards the cell *a* approaching *from* the periphery, or whether the bulging merely marks the spot where the cell *a* actually passed through the vessel-wall from its interior *towards* the periphery to take its place where it is now seen.

Passing on from Fig. 1, let us follow up the process in Fig. 2, which takes us on a stage further in the same direction. Here we have a cell, *a*, also lying at right angles to the existing vessel, in this case a capillary, which has not merely bulged, but actually bent its tube towards cell *a*. This cell may also be called bipolar, although the great bulk of its protoplasm lies between the capillary and the nucleus, which latter lies twice as far from the capillary as in Fig. 1, or, if we consider the direction of movement to be reversed, it has passed twice as far from the vessel as cell *a*, Fig. 1. We see here also two points of interest already referred to as illustrating fixed laws throughout:—1st, The point of the attached cell is not applied directly at right angles to the vessel, but lies alongside of it (as was also the case in Fig. 1), and in the second place, at the weakest part of the joint thus formed, we see the cell *c* placing itself so as to strengthen the newly-formed joint or splice. Let us next pass to a more advanced stage, as seen in *i*, Fig. 12, where the cell is applied to a formed vessel, as in Figs. 1 and 2. Here we have the joint strengthened by the application of another cell, as in Fig. 2, and we have the first traces of another important feature, the formation of the vacuole, or hollowing out of the cell whose protoplasm is to form the capillary wall. It is to be seen as a small white spot lying close to the nucleus on the side next the capillary, and will go on increasing in size until either directly or by the medium of an additional cell it forms a connection with the cavity of the formed vessel.

A fourth stage is seen in Fig. 3, where not only has the cavity of vacuolation become larger than in *i*, Fig. 12, and its junction with the capillary strengthened by the addition of two cells *b* and *c*, but already at its peripheral pole it has formed a connection in direct linear series with another bipolar cell, *d*, which has arrived at the same degree of development as *a* in Fig. 1. We shall hereafter refer to the bodies seen within the vacuole; in the meantime we have to notice that the vacuole has not become continuous with the cavity of the capillary, but this last phase is seen between *a* and *b*, Fig. 11, where the cavity is continuous with the lumina of the vessels to which they are attached.

So far we have traced the history of the development of a wandering cell into the first link of a developing blood-vessel. The formation of the second link includes the process of prolongation of a blood-vessel by a cell in direct linear continuation. Cell *d* in Figs. 3 and 4, represents the first stage, in which nothing particular is to be remarked beyond what we have already described. But in *d*, Fig. 5, we have a stage further advanced; a cavity has already vacuolated in the direction of *a*, the cell also vacuolating to which it is attached on the side next to the blood-vessel.

We may here call attention to an interesting peculiarity generally observed in cells vacuolating to form blood-vessels. Cell *d*, having as yet no cell on its peripheral end or pole, has thrown the whole of its protoplasma into the duty of forming an attachment with cell *a* on its central aspect; and for the same reason the cavity of vacuolation is formed on the central side of the cell nucleus, while cell *a*, which wishes to form a connection centrally with *b* and peripherally with *d*, has vacuolated at both sides or ends of its nucleus. Cell *i*, Fig. 12, showed the earliest stage in the carrying out of this principle, and we may see the third stage in cell *d*, Fig. 6, whose vacuolated cavity at the attached side of its nucleus has formed a junction with the cavity of the cell *a*, to which it is attached centrally, and which, having vacuolated before forming any attachment to cell *b*, shows the vacuolation only on that side of the nucleus nearest to its peripherally attached neighbour cell *d*.

In Fig. 7 we have the same process another stage further on, where not only have the vacuolated cavities in *a* and *d* become connected, but they have gone on extending themselves beyond their respective nuclei both centrally and peripherally; and further, the oblique splice or union between *a* and *d* has been strengthened at its weakest point by the addition of cell *c* placed according to the usual rule. In this figure the dotted line represents the continuation of the black silvered line that marks the union of the two cells *a* and *d* on the opposite surface of the tube. In all these examples it will be observed that we never have cells joining on the end-to-end principle, as stated by Arnold, but, as a rule, they overlap each other, as stated by Golubew, whether the junction is effected at right angles, as in Figs. 1 and 2, or in direct linear continuation, as in Figs. 6 and 7.

Hitherto we have been principally engaged with cells forming attachments at or from the periphery to blood-vessels. Let us now study those cases where the cells appear to be attached to or at the blood-vessels, and stretch out from them to form a junction with cells lying unattached. Cell *a*, Fig. 9, seems to offer a suitable example where the cell seems to make the capillary its base of operation, from which it stretches to form an angular junction with cell *d*, the peripheral point of another capillary. But on the other hand, cell *a*, Fig. 9, may be held to form the next stage to cell *a*, Fig. 1, supposed to be going in an opposite direction, that is to say from the periphery to the blood-vessel centrally. In other words, it is difficult or impossible to determine whether cell *a*, Fig. 1, should follow cell *a*, Fig. 9, as a type of cells acting or passing *from* the capillary, or cell *a*, Fig. 9, ought to follow cell *a*, Fig. 1, as a type of cells passing *to* the capillary. We may leave the question undecided, for it does not really much matter, and it is only useful in serving to reconcile the opposing views of Kölliker and Golubew as to whether it was by a cell passing *to* or passing *from* the capillary that new vascular extensions were formed.

If, however, we still follow the process in the sense that cell *a*, Fig. 9, is a type of cell acting at or from the blood-vessels, we may find an undoubted example of the same principle in cell *e*, Fig. 8, which, while lying upon the capillary, has begun to stretch out a short fine process of its protoplasm towards a wandering cell, *f*, of a circular form, which has not yet begun to elongate its protoplasm into the invariable bipolar shape which characterizes the wandering cell when it has undertaken the duty of a vessel-forming cell. Cells *m* and *n*, Fig. 12, are very good examples of this direction of development, and cell *k* is even more typical, because it has not yet begun to send out any process peripherally. It must, therefore, appear abundantly evident that the process of prolongation of newly forming blood-vessels by cells may be either towards or from the vessels. We have shown that, although cell *a* in Figs. 1, 2, and 9, and *i*, Fig. 12, may be on debatable ground, yet such examples as cells *a* and *e*, Fig. 8, are undoubtedly extreme examples respectively of direction of growth from and towards the blood-vessel.

Sometimes we have cells connecting the blood-vessels before the process of vacuolation has begun in them, as in Fig. 10, and again we may find earlier stages than that seen in Fig. 1, as for example in cell *f*, Fig. 6, which is evidently only approaching the capillary in course of formation, and lying at right angles to the joint between cells *a* and *b*, which are already forming the bend towards cell *f*, that we see so distinctly marked in most of the figures.

The manner in which the vessel-forming cell vacuolates or hollows itself out so as to form a tube is a question of great importance, which is not yet thoroughly understood, judging from the different opinions held by observers. This divergence in opinion is, we believe, to be accounted for by the fact that there are several different processes included under the head of vacuolation, differing in their course and results, although one process may be often found passing into another.

When a fixed cell passes into the embryonic form, as in the case of an inflamed epidermic or cartilage cell, or when the cell of embryonic cartilage vacuolates to make way for the development of bone, there is always a plentiful formation of new or young cells within the mother-cell; but although these processes have certain features in common with the vacuolating vessel-forming cell, they are in other respects unlike it. Again, we have a different process in the pathological vacuolation of cells, as we have shown it, for example, in the sweat-glands in leprosy, in which condition there is no proliferation or formation of new cells, but a cavity is formed between the nucleus and the cell protoplasm, which increases until it bursts. This vacuolation seems to have the effect of separating the nucleus from the rest of the cell substance, and thus leads to death of the individual cell. In such cases, the nucleus may be either compressed against the cell protoplasm forming the wall of the vacuole, appearing like the seal of a signet ring when viewed edgeways, and almost normal in shape when viewed from the front, or it may appear distorted and floating loosely in the fluid of the vacuole.

With neither of the above processes does vacuolation of the vessel-forming cell appear to be identical, although we have sometimes appearances shown apparently analogous with both. Thus in *g*, Fig. 12, the nucleus appears to be separated from the cell protoplasm, and floating loosely like a distorted blood-corpuscle within the fluid of the vacuole. On the other hand, in *a*, Fig. 3, we have several bodies floating within the fluid of the vacuole, but they are far too minute to be mistaken for blood-corpuscles. It has also been suggested that vacuolation is merely the formation of fat within cells; but this is certainly not the case with the vessel-forming cells, or indeed with any other vacuolating cell we are acquainted with. Apart from the fact which we have shown, that osmic acid blackens the fat formed in cells and leaves the vacuolar fluid transparent, we have also ascertained that in a developing fat-cell the nucleus is always surrounded by the protoplasm, however thin the layer may be. The fat is therefore formed in the protoplasmic substance itself, and not between it and the nucleus, which, moreover, is never found floating within the fat-globule, so that neither chemically nor physically is there any resemblance between the fat-cell and the vacuolating cell. Nor have we ever seen, as stated by Schaefer, a vessel-forming cell of a round form vacuolate and subsequently elongate itself. Without calling his statement in question, we may say that we have never met with even the commencement of a vacuole in a vessel-forming cell, until after it had elongated itself and clearly made up its mind to enter into the construction of a blood-vessel. Of course, if the cells are not fixed in the living form by the precaution we have referred to, they are almost certain to retract into the round form. This, indeed, occurred in some of the preparations we made for this research, from which drawings were made before we detected the fact that the cells had all retracted in the process of preparation; but here there was no question of subsequent elongation.

Bearing in mind what we have remarked in the above, let us proceed to trace the process of vacuolation in vessel-forming cells. At *i*, Fig. 12, we have seen that the vacuole may begin and be formed almost entirely in the substance of the cell protoplasm, and so close to the end of the cell nucleus that, were it not for the other examples, it would be difficult to decide whether or not it touches it. In such a case the nucleus remains evidently undisturbed upon the protoplasm, and the same is true of the nuclei at *a* and *d*, Fig. 7. In other cases the vacuole may form so as to sever the connection between nucleus and cell protoplasm, as seems to have taken place in cell *g*, Fig. 12. In *a*, Fig. 3, on the other hand, the cell evidently possessed more than one nucleus, or the one nucleus has broken up into its separate constituent bodies, as shown by Pouchet, the one condition in fact being only less advanced than the other. At all events, four bodies are seen within the vacuole, all very much smaller than blood-corpuscles, but one of them, from its staining less intensely than the other three, seems to be fixed or spread out normally on the vacuole wall, or in other words on the cell protoplasm, while the other three appear to be globular in shape and floating loosely within the fluid of the vacuole, whence they would probably float off into the general circulation when connection with it was established. This is possibly the same process as that described by Ranvier and Schaefer, by which blood-corpuscles are formed within cells, a hypothesis, however, the correctness of which we are not prepared to admit, for those floating bodies are certainly not blood-corpuscles; and when blood-corpuscles are found within cells or tubes, as in Figs. 13 and 16, we are prepared rather to accept the alternative explanation offered by the former histologist that such cavities are really retrograding blood-vessels, in portions of which blood-corpuscles have become, so to speak, shut up or imprisoned.

It is easy to understand the condition seen for example in Figs. 6 and 7, where the nuclei still remain normally attached to their cell protoplasm which is to form the wall of the future blood-vessel. But what is to become of *g*, Fig. 12, when its nucleus floats away? Will a new cell take its place when the circulation is established, or will the unnucleated protoplasm remain in the same position? This we are unable to determine, bnt the varied conditions seen in the different examples we offer lead us to suppose that, up to a certain stage, there is an analogy between the physiological and the pathological vacuolation of cells. In the vessel-forming cell, however, the accumulating vacuolar fluid finds an escape into the circulation before much damage is done to it; but there is no vent for the pathological vacuolar fluid, and it therefore ends by destroying the cell.

We have already referred to the appearances sometimes, but not always, seen where a line of elastic fibre marks out the track subsequently to be occupied by a loop of blood-vessel. Such an appearance is shown under a low power at A, Fig. 12, where, however, the tint of the fibres has been purposely exaggerated for the sake of distinctness. It is not our intention to enter into the question of the development of elastic fibres, of which so little that is satisfactory is known at the present day, but rather to inquire into the relation which may exist between them and the cells *e*, *f*, *h*, and *g*, which lie along the line of fibre or fibres and represent the only links as yet in the future chain of blood-vessel. After premising that these fibres are only a few of the many elastic fibres which exist at that spot, but which, as they do not interest us at present, we have not drawn, lest they should confuse the appearances, we have first to ask if those fibres existed before the cells placed themselves upon them, and if so, how was it that fibres came to be placed so exactly in the line of the future blood-vessel? Were even this answered, are we then to suppose that the cells *e*, *f*, *g*, and *h* clamber along the fibre from the nodal points *a*, *b*, and *c*, in the existing blood-vessel, in order to place themselves where they are especially wanted? All these and a host of other questions may be asked on this subject which our present knowledge does not enable us to answer; and we ourselves, after much study and examination of these and analogous appearances, have come to one hypothetical conclusion which seems to apply to them all.

We do not believe that the fibres existed there before the cells, but we believe that they were made by the cells as these passed into position; that just as a slug leaves a trail of slime behind it, those wandering cells may leave a trail behind them of a substance which is known afterwards as elastic fibre, and that this tendency accounts for the infinite shapes, sizes, branches, and positions occupied by such fibres. We distinctly offer the foregoing merely as a hypothesis, but a hypothesis which seems to fit all the various conditions.

In some cases, as at *d*, Figs. 5 and 7, the terminal vessel-forming cell is not continuous with a fibre, while in other cases, as at *a*, Fig. 1, the cell is distinctly continuous with or prolonged into a fibre. This difference may yet be found sufficient to decide whether the cell came centrally from the vessel or peripherally to it. The further growth in size and calibre of newly developed capillaries into veins and arteries, as may easily be conceived, takes place by the interposition of wandering cells between or upon the already existing cells of the wall. So much on the question of development.

## *Retrogression of Blood-vessels.*

While the process of formation of blood-vessels may be held to follow the same course under all circumstances, retrogression may take place from several causes and under different forms. These forms may be classed under the two great heads of physiological and pathological forms of retrogression; but it is not our intention to enter at present into the consideration of the changes which may take place under the latter head, regarding which it may be sufficient for us to say that, under pathological conditions, the cellular elements of the vessel walls may undergo either degeneration or malignant changes, which entirely alter their morphological appearances and destroy their physiological properties.

Confining ourselves, therefore, to physiological causes and forms of retrogression, we shall direct special attention to changes which result from, 1st, developmental, and 2nd, nutritive causes or conditions. Retrogression, as the result of insufficient nutrition, can best be studied in connection with the great groups or tracts of fat-cells to which innumerable blood-vessels are supplied within the same serous membranes where we have already studied their development. As the tracts of fat-cells disappear by physiological absorption, either from want of food in a young and active animal or through deficient power of assimilation of food in a very aged animal, so likewise do the blood-vessels which supply them break up and disappear when their presence there is no longer necessary. In both these instances no disease is present, and the resulting retrogression of blood-vessels is therefore purely physiological, and unconnected with any pathological condition. After the fat has been absorbed from all the cells, and these cells themselves are passing away, we find notable changes taking place in the whole of the blood-vessels passing to or supplying a fat-tract.

The changes taking place in the arteries are of two kinds. If the artery is directed solely towards the fat-tract, we find innumerable irregular constrictions of its lumen, the muscular coat at some parts having contracted so as to nearly obliterate that lumen, leaving moniliform groups of dilatations enclosing numerous blood-corpuscles along its course. Very often, however, the afferent and efferent vessels passing to and from the capillary plexus of a fat-tract are destitute of muscular elements in their walls, except at the point where the afferent vessel begins as a branch passing off at right angles from an artery of considerable size. In such a case a coat of muscular fibres extends upon it for a distance of five or six diameters from its point of junction with the artery, so that when it is no longer necessary for a nutrient current to pass towards the fat-tract, this sphincter-like muscular coat contracts, and thus shuts off the blood current.

The changes in the veins or vein-like afferent vessels are not less strongly marked. These vessels contract their lumen by causing the one layer of cells which form their wall to contract laterally, and at the same time to become much thicker, so that when we focus the Microscope upon the plane of the centre of the vessel, we find the lumen obliterated, and the cells of the wall, instead of having their nucleus standing in relief from the inner surface of the vessel, now appear with a considerable thickness of their protoplasm covering the nucleus on the internal as well as upon the external surface of the vessel wall. This contraction does not seem to be due to any nervous influence, but may in great part be due to the pressure externally of the gelatinous matrix in which the vessels lie embedded, and partly to their own protoplasmic contractile nature, these actions being permitted by the absence of the distending fluid within them.

It is, however, in the capillaries that the best marked changes are to be observed. While the whole capillary plexus supplying or ramifying in a tract of empty fat-cells contracts the lumen of the vessels throughout, it is only the loops of capillaries forming the outer border or edge of the plexus which first retrograde and break up. In such cases we may observe constriction, or what really ought in most instances to be called a withering, at one or more points on the course of the loop, the capillary wall appearing to become much thinner, as at *b*, *b*, Fig. 15, and losing the plump cylindrical appearance seen in well nourished capillary walls. At the same time the withered portion seems to lose its faculty of being stained by certain staining agents which colour satisfactorily those portions of the capillary intervening between the withered-like constrictions. Finally, the capillary breaks at one or more places, and the process of disintegration is carried on at the extremities of the free ends, one cell after the other breaking off, as at *a*, Fig. 19, and appearing to move away, by means of long delicate processes or branches, from the seat of its former functions as an individual element in a capillary wall.

The thinning or withering of the wall which we have referred to, is evidently a process of absorption of the excess of protoplasm which the cell had accumulated after it had taken its position as a part of the capillary wall at its first development During this absorption, moreover, particles of a peculiar fatty-like substance show themselves, as at *e*, Fig. 19, on the absorbing protoplasm, which refuse to stain with colouring reagents; but when logwood has been used it appears of a yellowish-brown colour, in strong contradistinction with the blue or purple tint of the healthy nuclei or protoplasm.

More peculiar still is the relation which the intercepted portions of capillary bear to the blood-corpuscles, numbers of which in many cases become shut up in such intercepted portions, as in Figs. 17 and 19. For the purpose of studying the changes undergone by those blood-corpuscles, we especially recommend the pyrogallate of iron staining process, for while the nuclei and protoplasm of the healthy elements are very well shown by it, the blood-corpuscles seem to have a special affinity for the colouring matter and stain intensely black, so that there is no difficulty in watching their behaviour until they have become completely absorbed. This faculty of staining intensely is probably due to the great amount of iron which they normally contain, but whatever the cause may be, the fact is very evident. The change which takes place in these elements can be easily followed, even if it cannot be explained. The corpuscles enclosed in a portion of capillary undergoing the thinning or absorbing of its protoplasm, are seen to become paler and transparent, as at *b*, Fig. 19, and smaller in size, until a point is reached when they can no longer be detected, as if they had dissolved away within the absorbing protoplasm of the capillary cell, and no vestige of them remained behind. It is highly probable that the yellowish fat-particles, *c c*, Fig. 19, already alluded to, are really composed of a modification of the blood pigment from the corpuscles, a point we have not the necessary instruments to determine.

This reference to blood-corpuscles within intercepted portions of capillary, leads us to the much debated question of the presence of blood-corpuscles within cells already referred to, and of the signification of those appearances in what have been named vaso-formative cells by Professor Ranvier, with regard to which we have also given Dr. Thin's opinion that they are merely spaces in the omentum to which the term cell is not applicable. This question also brings us to the consideration of the retrogression of blood-vessels physiologically in connection with the development of an animal. Professors Ranvier and Schaefer independently announced the discovery of cells containing blood-corpuscles, the one having found them in the skin of embryo rats, and the other in the serous membranes of embryos or newly born animals. Both of these histologists described these cells as ultimately becoming connected with or forming part of the circulation, but the former has specially studied them in this relation and given to them the name they now bear of "vasoformative cells."

It is unnecessary for us at present to enter into his arguments for considering these structures as connected with the development of blood-vessels, as we are more concerned with certain remarks which he makes at page 633 of his 'Traité d'Histologie,' where he advances the hypothesis, only to reject it, it is true, that having regard to the great changes continually taking place in the circulation of the embryo, and after birth more especially in connection with the obliteration of the branchial arches, the ductus arteriosus, &c., it may be plainly argued that those cavities containing blood-corpuscles are really portions of the circulation becoming obliterated, and that the intercepted portions are really parts of pre-existing capillaries.

However startling such a hypothesis may appear at first sight, we are surprised to find Professor Ranvier reject it as being inapplicable, at all events, to most of the examples he has studied. For our part, we subscribe fully to it, not as a hypothesis, but as a fact, for there is certainly in this research no fact easier of demonstration than it is. Our reasons are the following: In the first place, there is complete identity between these vasoformative (so-called) cells containing blood-corpuscles, and the intercepted portions of retrograding capillaries containing blood-corpuscles, in animals where nutrition has been insufficient. In the second place, if one studies the omentum of newly-born kittens, as recommended by Ranvier, nothing can be clearer than the fact that retrogression and development of blood-vessels are going on side by side, and that the two processes are so distinct that there is scarcely any possibility of confounding the one with the other. We give a drawing of such an example, Fig. 13, where retrograding and developing vessels are lying parallel and close to each other, so that a glance ought to be sufficient to distinguish between them. In this camera lucida drawing $a, a'$ are terminations of branches still in connection with the original channels of the circulation, and $b, b'$ are what are called vasoformative cells, containing blood-corpuscles, but which in reality are portions of the capillary which originally stretched from $a$ to $a'$, and are now identical with Figs. 15, 17, and 19, from a rat which died of old age and inanition. In Fig. 13 we also see a new vessel $c$, from which three new branches $d, d', d''$, are being developed, in conformity with the process we described in the early part of this paper.

It is therefore evident that the physiological retrogression of blood-vessels follows the same course, whether it be due to insufficient nutrition or assimilation of food, on the one hand, or to changes in the development of an animal, on the other, the only peculiarity being that while in the latter case development and retrogression go on simultaneously and side by side, in the two former cases only retrogression goes on at one time, there being no room or reason for development, just as during development of blood-vessels in the adult there can be no retrogression at the same time.

Bearing in mind, therefore, the small bodies sometimes seen in vacuolating cells during the formation of blood-vessels, as in Fig 3, these bodies being in general too small to be mistaken for blood-corpuscles, we have come to the conclusion that the vasoformative cells are neither cells nor cavities, but are only intercepted portions of a retrograding capillary or larger vessel, as the case may be, and still containing the blood-corpuscles which lay within the vessel before it broke up into fragments.

The results of this research may be summarized in very few words. When new blood-vessels are necessary, the wandering cells come and plant themselves in position according to a definite plan; through these, when hollowed out, the circulation of the blood is established or permitted. When the blood-vessels of any part are no longer necessary, they break up into their individual cells, and these separated links of the broken-up chain move off in their original condition of wandering cells. A simple cycle of life, or functional phase; much simpler, indeed, than the cycle we have described in the life of the fat-cell (a companion study already published in this Journal), but none the less evident because it is simple.

---

## EXPLANATION OF PLATE XV.

(Drawings and preparations by the authors.)

The first fourteen figures illustrate the development of blood-vessels, and Figures 13 and 15 to 19 illustrate their retrogression. Figures 11, 13, and 16 are from the omentum of the newly born kitten; Figures 15, 17, and 18 are from the broad ligament of the rat; the rest are from the broad ligament of pregnant mice. They have all been stained by silver and pyrogallate of iron, and mounted in glycerine.

Fig. 1 shows a wandering cell *a* forming a junction with a blood-vessel *b*, which, as if in sympathy, has dimpled or bulged its wall towards the new comer.

Fig. 2.—A similar cell *a*, in like relationship to a capillary *b*, but in a stage further advanced than Fig. 1. In this case the capillary has bent its whole tube in sympathy. A second cell *c* has placed itself against the joint as if to strengthen it.

Fig. 3.—A still further advanced condition, in which a second cell-link *d* has been added to *a*; *a*, moreover, is vacuolating, and shows four small globular bodies within the vacuole. An earlier stage of vacuolation is seen in Fig. 12, at *c* and *i*.

Fig. 4.—A still further advanced condition, in which cells *a* and *c* are vacuolating respectively towards *b*, the proximal, and *d*, the distal communication.

Fig. 5.—A similar condition where vacuolation has been going on in cells *a* and *d* before connection is established with the capillary *b*.

Fig. 6.—A similar condition where the vacuoles in two cells *a* and *d* have joined to form one cavity before forming a communication with a third cell, vacuole *b* intervening between them and the capillary. The isolated cell *f* to the right of Fig. 4 belongs to this figure. [Fig. 7

Fig. 7.—A similar condition, where the junction of two cells *a* and *d* and their vacuoles forming one cavity is very plainly marked by silver lines. The dotted line represents the continuation of the silver marking on the lower surface of the tube formed. A third cell *c* has placed itself, according to rule, against the joint formed by *a* and *d*, but communication has not yet been effected with the lumen of the capillary.

Fig. 8.—Shows the formation of a capillary plexus. The vacuoles in *a* and *d*, having formed one cavity, are about to establish a communication with the blood-vessel *b*. Three cells by their processes are forming a junction at *g*. Cell *e* is stretching out a process to form a communication with a wandering cell *f*, which has not yet begun to elongate its protoplasm.

Fig. 9 shows a junction being formed at an acute angle by cells *a* and *d*, so as to construct a loop between two capillary loops, but only cell *d* has vacuolated, and it has not yet connected its cavity with the circulation.

Fig. 10.—A similar loop between two capillary loops *g* and *h*, being formed by three cells *a*, *b*, and *c*, none of which has as yet begun to vacuolate.

Fig. 11.—A branch capillary developing in accordance with the plan seen in the preceding figures, cell *a* having vacuolated, and the vacuole being about to become connected with the lumen of the blood-vessel *b*. This figure is to be compared with Fig. 16, which apparently represents retrogression, both figures being taken from the same field of the Microscope in a preparation of the omentum of a newly born kitten.

Fig. 12 represents the formation of a large capillary loop or plexus. At A the whole plan has been drawn under a low power of 100 diameters, while the special points of interest have again been drawn at the same high power as the rest of the drawings. The nodal points in the existing capillaries to be connected are formed at *a* and at *b* and *c*, while *e*, *f*, *g*, and *h* represent some of the links on the future chain. Of these links, *g* is formed of three cells joined together in the usual plan, and of these, *g* and *g′* are vacuolating; a nucleus-like body, resembling also a blood-corpuscle seen edgeways, appears to float free in the vacuole of *g*.

Fig. 13 shows development and retrogression of vessels going on at the same moment and in the same field of the Microscope, owing to changes in the circulation at birth. *a a′*, terminations of a retrograding vessel still connected with the circulation; *b b′* portions of the blood-vessel formerly continuous from *a* to *a′* and still containing the blood-corpuscles *e e*, which remained in them at the moment of separation; *c* newly developed vessel with three branches *d*, *d′*, *d″*, in course of development; *f f*, nuclei of the cells of the wall of the capillary.

Fig. 14 shows a developing loop *a* becoming connected with the circulation at *b b′*, the component cells of which follow the rules already noticed.

Fig. 15 shows retrogression of blood-vessels in old age, and failure to assimilate food, which was plentiful. The loop *a* is about to break off from the circulation at *b b′*, being exactly the converse of Fig. 14; blood-corpuscles at *e e*; nuclei of the cells forming capillary wall at *f f*.

Fig. 16.—A drawing under higher power of *b′* Fig. 13, representing a so-called vasoformative cell, but in reality a portion of a retrograding blood-vessel. Compare with developing capillary in Fig. 11, from the same preparation.

Fig. 17.—A small portion of a long capillary loop in retrogression (from a rat which had evidently died of starvation), being the portion still attached to the plexus, but shut to the circulation. *e e*, blood-corpuscles; *f f*, nuclei of cell wall.

Fig. 18.—A similar portion of retrograding capillary, collapsed throughout, and undergoing absorption. It is about to break up into its constituent cells *a a*. From the same preparation as Fig. 17.

Fig. 19, from the same animal as Fig. 15, shows a portion of retrograding capillary from which one cell *a* is about to separate itself. That cell contains two blood-corpuscles *b*, nearly absorbed. *c*, granular matter of the nature of fat or of blood-pigment; *d d*, other blood-corpuscles still normal; *e e*, nuclei of wall of capillary.

Fig. 13 is drawn to a scale of 170 diameters; Figs. 17 and 18 to 280 diameters; all the others under the same power of 330 diameters, by the aid of the camera lucida.

## XIX.—*On a Parabolized Gas Slide.*

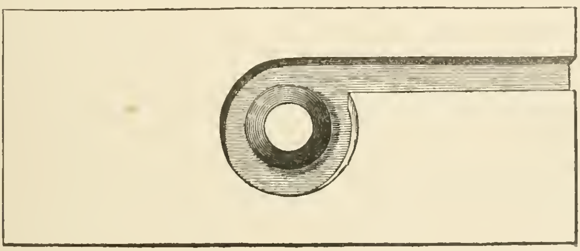
By James Edmunds, M.D., M.R.C.P. Lond., F.R.M.S.

(*Read 9th June*, 1880.)

This is a simple and inexpensive contrivance which has been made for me by Messrs. Beck for the purpose of examining bacteria, blood-globules, &c., while gases or vapours of various kinds are projected into an annular space from which they rapidly diffuse into an object which is being observed under the Microscope.

The slide * (Figs. 52 and 53) is constructed of a slip of optical crown glass 3 inches by $1\frac{1}{4}$, and in thickness from three to four sixteenths of an inch. An annular zone eleven-sixteenths of an

Fig. 52.



inch in diameter and nearly one-eighth inch deep is turned out of the slide, so as to leave a central pillar three-eighths of an inch across, and the top of this pillar is then turned down, so as to

Fig. 53.

leave a central area nearly a quarter of an inch in diameter, and exactly on a level with the general surface of the slide. The outside of the central pillar is then smoothed into an approximately paraboloidal surface, and brought to an optical polish. A straight groove of the same size and depth as the annular zone is then cut out of the slide parallel to its long side and at a tangent to the annulus. Into the longitudinal groove of the slide two fine glass tubes are cemented. One of these is left projecting beyond the end

* Fig. 52 shows the upper aspect of the slide excavated with the groove and annulus, the totally reflecting parabolized surface of the central pillar, and the clear central area left on a level with the top of the slide. Fig. 53 gives a longitudinal section of the slide drawn through its centre, and showing the annular gas channel, the central paraboloid, and the thin cover.

of the slide, so as to be connected with a slender elastic tube through which gases or vapours may be projected, and which, after traversing the annulus, escape by the other tube. A ring of olive oil is set around the annulus upon the surface of the slide, and the cover containing on its centre the drop of liquid to be examined is then so placed over the annulus that a film of fluid less than a quarter-inch in diameter lies between the top of the central paraboloid and the cover, while the margin is sealed by the oil. Thus the object may be examined, firstly by itself, and afterwards while various gases are passed through the surrounding annular space, and the changes produced, say on blood-disks by dry or moist air, alcohol vapour, ammonia, acetic acid, carbonic acid, &c., can be watched and repeated at pleasure.

If light be thrown into the central area from beneath by means of a two-inch objective, the object is seen negatively upon a bright field, while if the condenser be decentered the light is thrown upon the parabolic surface and is totally reflected into the object at such angle as to give a positive image upon a black background under a dry eighth or sixteenth, as with the immersion paraboloid. The glass tubes may be cemented into the groove by means of dough, putty, plaster of paris, shellac, &c. If very hot sealing-wax be used the slide is apt to crack, unless previously heated in water. Diaphragms of black paper or tin-foil may be gummed on to the lower surface of the slide, so as to stop out the central area when black-field observations are wanted. Both as a gas slide and as a simple form of the immersion paraboloid, it works conveniently and efficiently.

# RECORD

OF CURRENT RESEARCHES RELATING TO

# INVERTEBRATA, CRYPTOGAMIA, MICROSCOPY, &c.*

## ZOOLOGY.

### A. GENERAL, including Embryology and Histology of the Vertebrata.

**Development of the Vertebrate Eye.**† — Professor Lankester directs attention to the myelonic or cerebral eye which the Ascidian tadpole possesses in common with all Vertebrates. All other animals which have eyes develop the retina from their *ectoderm*. It is easy to understand that an organ which is to be affected by the light should form on the *surface* of the body where the light falls. It has long been known as a very puzzling and unaccountable peculiarity of Vertebrates, that the retina grows out in the embryo as a bud or vesicle of the brain, and thus forms *deeply* below the surface and *away from the light*. The Ascidian tadpole helps us to understand this, for it is perfectly transparent and has its eye actually *inside* its brain. The light passes through the transparent tissues and acts on the pigmented eye, lying deep in the brain. We are thus led to the conclusion—and he believes this inference to be now for the first time put into so many words—that the original Vertebrate must have been a transparent animal, and had an eye or pair of eyes *inside* its brain, like that of the Ascidian tadpole. As the tissues of this ancestral Vertebrate grew denser and more opaque, the eye-bearing part of the brain was forced by natural selection to grow outwards towards the surface, in order that it might still be in a position to receive the influence of the sun's rays. Thus the very peculiar mode of development of the Vertebrate eye from two parts, a brain-vesicle and a skin-vesicle, is accounted for.

**Embryology of Batrachians.**‡ — These 'New Researches' of Professor Van Bambeke consists of two parts: (I.) on the envelopes of the egg and external embryonic changes of Tritons and Axolotl, and (II.) on the cleavage of the egg in Batrachians generally.

I. 1. Having in a previous essay described the egg proper (vitelline sphere or globe) the author now distinguishes its five envelopes as (1) the vitelline membrane, (2) chorion, (3) inner capsule, (4) outer capsule, and (5) adhesive layer. The first is thin and structureless,

* ☞ It should be understood that the Society do not hold themselves responsible for the views of the authors of the papers, &c., referred to, nor for the manner in which those views may be expressed, the object of the Record being to present a summary of the papers *as actually published*. Objections and corrections should therefore, for the most part, be addressed to the authors.

† 'Degeneration: a chapter in Darwinism' (8vo, London, 1880).

‡ 'Arch. de Biologie,' i. (1880) pp. 305-380 (4 plates).

closely fitted to the yolk, with little projections on its inner surface, corresponding to the vitelline pores, and a fold applied to the first meridional groove. The chorion, also transparent and homogeneous, tightly invests the inmost membrane, like which it may be a mere transformation of the outer substance of the yolk; or is it not rather a product of the *granulosa*, since it takes no share in the act of cleavage? The chorion is separated from the inner capsule by a liquid in which the egg moves freely, touching the capsule by its lowest part. Frequently the egg of Triton, still within the oviduct, has its vitelline sphere of an elliptic figure (persisting after extraction), the space about the chorion being at this time filled with jelly. In Triton the liquid is often bistre-coloured and the inner capsule is much thinner than in Axolotl, where its optic section displays a fibrous aspect. The liquid of Axolotl at first contains brilliant granules and little opaque clots which subsequently disappear. The outer capsule is transparent as glass, elastic, very resistant, bluish when seen against a dark ground, and homogeneous or but feebly striated parallel to its surface; elliptic in Triton, it is spherical in Axolotl. Like the inner capsule it is rapidly deposited in the first moiety of the oviduct. Here begins also the formation of the adhesive layer, to be completed in the further portion of the duct. In Triton this layer is thin, easily detached from the outer capsule; not so in Axolotl, where it is much softer, swelling by contact with water and resembling a viscous mass. Minute depressions, arranged with tolerable regularity, are often seen to mark a part of the thickness of the adhesive layer. These are probably the stigmata left by diatoms, which in other places occupy spots of corresponding diameter.

I. 2. Professor Van Bambeke distinguishes seventeen stages between fecundation and the exit of the embryo from the egg. Stage I., ending with the beginning of cleavage, he has treated in a previous memoir. Stage II., from cleavage to the commencement of epiboly, is discussed in the second Part of this essay. Stages III.–XVII. are here duly described.

II. The author has studied cleavage of the egg in three species of Triton (*alpestris*, *punctatus*, and *palmipes*), in Axolotl, *Pelobates fuscus*, and the common toad. The latter is here referred to but cursorily, for its strongly pigmented eggs offer peculiarities to be explained in a future memoir. Six stages, ending with the formation of the morula, are fully described and illustrated. An historical sketch is added in which the results detailed are compared with those of Goette, Bütschli, O. Hertwig, Scott and Osborn, and Benecke: the researches of Salensky on the sterlet, with the more general views of Flemming, Fol, and Mayzel, are also noticed. The whole demands an attentive study. We give the author's own "conclusions."

1. Cleavage is set up by the first embryonic nucleus (*der erste Lebenskeim*, Goette), placed in the upper hemisphere, at the limit of the ecto- and endodermic segments. The axis of the egg, which originally passed through the centre of the germinal depression, now

traverses the embryonic nucleus and abuts peripherally at a point where the first meridional groove will appear; in other words, the upper or active pole is displaced.

2. The nucleus undergoes transformations comparable to those observed in the egg of most organisms (cleavage-amphiaster). There are three principal phases, to the last only of which the descriptions and figures of Goette apply; so that the egg-nucleus of Amphibians makes no exception to the general rule.

3. As Goette has shown, a clear rim, which I call *cleavage plate*, precedes the appearance of the peripheric groove. It is most clearly indicated in the plane of the future equatorial cleavage, thus establishing a marked separation between the ectodermic spherules and the endodermic mass. It has manifestly for its seat the line of separation between what I term the ectodermic and endodermic extremities of the egg.

4. The meridional grooves arise as pale, strongly marked gutters along the pigmentary cap of the upper hemisphere; afterwards, by effacement of the cleavage-spherules, the gutter becomes a simple groove. The pigmentary line of separation then belongs, at least for the most part, to the cortical layer.

5. In the endodermic extremity, the meridional divisions increase in activity from the centre towards the periphery. Accordingly, at any given moment, the cleft portion covers a still undivided region, represented in sections by an ellipse whose base corresponds to the lower pole of the egg.

6. Certain phenomena, such as the impulsion of cortical pigmentary masses towards the interior of the egg, the irregularities in the planes of division observable in some phases, &c., are explicable only by admitting the existence of contractions of the protoplasm of the egg during cleavage.

7. The roof of the segmentation-cavity, at first monoderic, becomes polyderic. There is here no difference between the eggs of Anoura and Urodela.

**Vital Properties of Cells.***—M. Ranvier directs particular attention to the appearance of nuclei in dead cells; taking for example the lymphatic and "fixed" cells of the cornea, he points out that, during life, no nuclei can be made out in them, but that these appear after the death of the cells. The reason of this appears to be that, during life, the nuclei are not apparent because their refractive power is very much the same as that of the surrounding protoplasm. At death, changes take place in the protoplasm, so that they then become apparent. In illustration of this he has performed the following experiments:—

(1) Two corneæ were carefully removed from a frog, and were both placed in damp chambers, exactly similar in construction; one, in a room of 23°, was submitted for ten seconds to the action of an electric current; this was sufficient to kill some of the cells, and their nuclei became apparent two minutes afterwards. The other was

* 'Comptes Rendus,' lxxxix. (1879) p. 318.

submitted to the same current, at a temperature of 2°; 45 minutes elapsed before the nuclei became apparent.

(2) Somewhat similar experiments were undertaken with eyes from a frog, which were respectively submitted to a temperature of 33° and 80°, together with an electric current; in the former the nuclei appeared within an hour after the experiment; in the latter not at all.

(3) The cornea of a frog was submitted to an induction current sufficiently strong to kill the cells, and was then kept for two hours in a damp chamber at a temperature of 33°; it was then found that the nuclei were broken up into fragments or small spherical granules. The action in this case appears to have been that the currents broke up the nuclei, and the work thus commenced was completed by "autodigestion."

**Coalescence of Amœboid Cells into Plasmodia.***—The coagulation of the perivisceral fluids or the blood of Invertebrata as studied in the air-tight chamber presents, as Mr. Geddes shows, some significant phenomena. Thus the amœboid corpuscles of the earthworm's perivisceral fluid, those of the gill of *Pholas*, the corpuscles of *Patella* and *Buccinum*, during coagulation become aggregated into groups, which rapidly become individualized, and themselves send out pseudopodia.

Of the two kinds of corpuscles possessed by *Pagurus*, the elongated, coarsely granular ones do not possess this power, which however belongs to the finely granular ones, which may enclose the former kind in their clot; the same distinction is observed in *Carcinus mœnas* and *Cancer pagurus*. The corpuscles, with their looped pseudopodia, of the common starfish send out pseudopodia, as in the previous cases, from a united mass. The Echinoidea, as exemplified by *Echinus sphæra*, show the phenomenon most strikingly. The clear perivisceral fluid contains coarsely and finely granular corpuscles similar to those of *Pagurus*, besides coloured ones. The clot commences as a cloudiness of the liquid; the cloud gradually becomes denser until a small brown pellet is the result. This is formed entirely of the finely granular corpuscles which run first into small heaps, these uniting into larger ones until a large mass is formed containing the nuclei and granules in an endoplasm, and sending out generally filamentous pseudopodia from a hyaline ectoplasm which is clearly differentiated from the former; the pseudopodia sometimes lengthen to an immense extent.

A comparison of these cell-formed clots with those of the *Myxomycetes* appears to demonstrate a true homology between them; and the possession of the same power by the Rhizopods, *Microgromia*, *Rhaphidiophrys*, *Phonergates*, &c., shows it to be at any rate a very widely spread function of amœboid cells.

**Structure and Development of Dentine.**†—M. Magitot gives a short account of his investigations on this structure, which have led him to the conclusion that it is not, as some writers—Duvernoy e. g.—

* 'Proc. Roy. Soc.,' xxx. (1880) p. 252, and 1 plate.
† 'Comptes Rendus,' xc. (1880) p. 1298.

have imagined, a secreted product, but that it is a living tissue; this view, however, is now old, and appears to owe its origin to Professor Owen, who* pointed out the striking similarity which obtains between dentinal and ordinary osseous tissue.

**Ovary of Mammals.**†—Dr. Jules Macleod (of the Ghent Histological Laboratory) describes the ovaries of the bat (*pipistrelle*), mole, and stoat. Successful results were obtained by the method of double coloration. The ovary and oviduct are very closely connected by means of their serous investment, as in other mammals except man. The parenchymatous zone of the stroma is not resolvable into the separate layers (cortical, subcortical, and follicular), distinguished by His. In the stoat this zone, with its peripheric lobules, is copiously developed and sharply limits the included medullary vascular stroma; while in the mole and bat these two portions of the stroma lie side by side, the one not being wrapped round the other. In the bat their structure is nearly identical. The ovary of the adult mole offers seasonal differences as to size, structure, and orientation, which are not constant, and merit further study. The serous endothelium of the bat passes gradually into the adjoining ovarian epithelium. The cuboid epithelium of the mole is very distinct from the endothelium of the serous layer, which, as in the bat, is exceptionally extended over most of the ovary. In the stoat the epithelium is nearly cylindric. The adult intertrabecular ovarian stroma of these three mammals is largely made up of elements comparable to the *Plasmazellen* of Waldeyer, whose interpretation of the Graafian follicles also coincides with the description of their structure and development here given. Finally, the ovary contains medullary cords, which the author, following Balfour, regards as homologues of the male seminiferous tubules. These cords are especially abundant in the mole, less so in the bat; in both the contiguous ovarian surface is closely invested by its capsule, as is the testicle by its *albuginea*.

**Influence of Saline Solutions on Protoplasm.** ‡—The researches of M. Costerus were stimulated by the results obtained by Professor de Vries in examining the influence of acids on vegetable substances. The solutions employed by the former contained chiefly chloride of sodium or nitrate of potash, and the object of examination was most frequently the red beet-root.

The following was his method of investigation:—In glass capsules, about 3 cm. high, he placed some very thin slices of beet-root, which were covered over by water; similar slices were immersed in a 10 per cent. solution of sea-salt. It resulted from these experiments that, at the end of a few days, the slices in the salt-solution completely lost their colour, whereas those in pure water for some considerable time after, retained their colour. Similar results were obtained with solutions of nitrate of potassium.

To what was this effect due; is more oxygen absorbed by water

* 'Comptes Rendus,' ix. p. 784.

† 'Arch. de Biologie,' i. (1880) pp. 241–278 (2 plates).

‡ 'Arch. Néerl. Sci. exact. et nat.,' xv. (1880) p. 148.

when the salts are absent from it? To resolve this question the author, instead of using thin slices, experimented on pieces 1·2 and 5 mm. in thickness, and 5 mm. in length and width. The access of air being thus hindered, it was, obviously, possible to see whether the already observed differences were altogether to be ascribed to the greater difficulty of respiration in salt-solution; and these observations led him to the conclusion that, when less air penetrates, the difference between cells in pure water and in salt-solution is less distinctly marked. The next thing was to subject the slices of beet-root to an air-pump, before commencing the investigation; pieces thus treated showed a remarkable result, inasmuch as the balance was after fifteen days in favour of the pieces immersed in the salt-solution.

Other results confirm a conclusion which may be thus formulated; the cells of the red beet-root, when air has free access to them, are injuriously affected by salt-solutions, while when the air is removed or is only present in small quantities these solutions have a sustaining effect. The former point is the only one which the author at present attempts to explain, and this explanation is found in the fact that saline solutions absorb less gas than pure water, and that the co-efficient of absorption decreases in proportion as the solutions become more concentrated.

**"Law of Association."** *—M. Edmond Perrier considers that the oft-repeated objections to the theory of evolution leave the fundamental principles of that doctrine untouched. Having gone over the various organisms from lowest to highest, seeking out, not the differences, but the points of similarity between them, he believes he has ascertained that a simple and very general law presided over their formation, that they were derived from one another by a constant process, and that he has succeeded in adding a few arguments to the theory of the genealogical relationship of species.

This law M. Perrier terms the "*law of association.*" The process by which it has produced the majority of organisms is the "*transformation of societies into individuals.*"

Ever since it was shown that every living being was composed of microscopic corpuscles more or less resembling one another—that similar corpuscles capable of leading an independent existence constituted of themselves the simplest organisms—it has been thought that the most highly organized animals and plants were comparable to vast associations of distinct individuals, each represented by one of these living corpuscles or cells. In the same organism the life of each cell is so independent of that of its neighbours, that it is possible to destroy one set of cells without affecting the others. Despite the common bond which unites them, these cells, sometimes very dissimilar, retain their individuality and perform their different functions for the wellbeing of the whole community, like the various members of a populous town.

By "association," however, is not meant that the individuals band

* 'Revue Scientifique,' Dec. 1879, p. 553. See 'Pop. Sci. Rev.,' iv. (1880) p. 30.

together like bees or other gregarious creatures; and to illustrate this law it is necessary to refer to forms lower down in the scale in which the component individuals are united to each other by a common tissue. Accordingly, M. Perrier turns first to the Hydroids, and, after referring to the budding of the *Hydræ*, shows that in compound forms such as *Cordylophora lacustris,* and in most of the marine Hydroids, what is only occasionally produced in *Hydra* becomes normal. But a new phenomenon occurs—a veritable system of division of labour is effected between the members of the same colony. At first all were similar, all performed the same functions in the same manner, but speedily each individual became specialized. One devotes itself exclusively to the capture of food, another to the elaborating of the nutritive material, and a third to reproduction, so that in the end all these individuals, which originally had no need of one another, become mutually necessary. Among the Hydractiniæ we may reckon no fewer than seven kinds of individuals fulfilling different functions. It might seem to be an exaggeration to attribute the quality of individuals to the different parts. We have here, it might be said, simple organs; but organs of what? They are just as independent of each other and of the nutritive individuals as the latter can be of one another. Hence they are not organs of those polyps. Are we to see in them organs of the colony? This is at once to recognize that the colony has an individual character, and consequently to assume the transformation we seem to demonstrate. But how has a colony been able to acquire such organs? Whence can they have arisen if not from a transformation of the individuals composing it?

The author considers that there is no occasion for hypothesis in order to demonstrate that these *colonial organs* are the equivalents of true individuals. The buds which give origin to the different kinds of individuals in a colony of Hydractiniæ, all originate in the same way, and are for a long time so similar that there is nothing to enable them to be distinguished. In *Podocoryne* the humble sac which represents the sexual individual is replaced by a Medusa much higher in organization than the *Hydra* itself, which detaches itself on its arrival at maturity.

The same train of reasoning is applicable to the Siphonophora and also to the Coralliaria, which are more highly organized and exhibit a more complete amalgamation of the component individuals, each of which in the Coralliarian polyp may be considered as a number of Hydroid polyps rolled into one.

This transforming of a number of individuals into one individual can likewise be traced out in the Worms. Van Beneden established that each of the joints of a tape-worm is the equivalent of a Trematode; and, at a yet earlier period, naturalists considered the segments of worms and insects to be equivalent units, each having an actual individuality, which they called zoonites. Sea-urchins and star-fishes have also been looked upon as colonies of worms united by their heads.

Can we say the same of the Mollusca and Vertebrata, all the parts of which seem to be so intimately fused together? This is what has still to be investigated; but whatever the result arrived at, the generality of the principle of association will not be at all invalidated, for if in this case simple individualities never existed, we should have to compare the Mollusca and the Vertebrata with the primordial individuals, the combinations of which produced the other types. How did these individuals themselves originate?

The *Hydræ* and other analogous organisms, the author thinks, furnish the answer; and after dealing with these, he says:—

"Thus, even if it be shown that the Vertebrata and Mollusca do not result from the fusion of simpler beings once capable of an independent existence, they will not, any the less, be *colonies of cells*. The 'law of association' will consequently lose none of its generality, and will remain the fundamental law of the development of the animal kingdom, including and governing those *laws of growth*, *organic repetition*, and *economy*, that for a long time past have engaged the attention of physiologists," while it explains hitherto inexplicable homologies.

The author then passes to the consideration of protoplasm, and from the incapacity of the protoplasmic masses to exceed a certain size, draws the conclusion that all creatures that exceed this size must be formed of several distinct masses of protoplasm—that is, are colonies. "Thus the generality of the law of association is shown to be a consequence of one of the fundamental properties of protoplasm."

**Degeneration.***—Professor E. Ray Lankester has published, as a separate volume, the lecture which he delivered on this subject at the British Association meeting in 1879.

In attempting to reconstruct the pedigree of the animal kingdom, and so to exhibit correctly the genetic relationships of all existing forms of animals, naturalists have hitherto assumed that the process of natural selection and survival of the fittest has invariably acted so as either to improve and *elaborate* the structure of *all* the organisms subject to it, or else has left them unchanged, exactly fitted to their conditions, maintained, as it were, in a state of *balance*. It has been held that there have been some six or seven great lines of descent—main branches of the pedigree—such as those of the vertebrates, molluscs, insects, star-fishes, and so on; and that along each of these lines there has been always and continuously a progress—a change in the direction of greater elaboration.

Each of these great branches of the family tree is held to be independent. They all branch off nearly simultaneously from the main trunk. The animal forms constituting the series in each of these branches are supposed to gradually increase in elaboration of structure as we pass upwards from the main trunk of origin and climb further and further towards the youngest, most recent twigs. New organs have, it is supposed, been gradually developed in each series, giving their possessors great power, enabling them to cope more successfully with others in that struggle for existence in virtue of

* 'Degeneration: a chapter in Darwinism.' (8vo, London, 1880.)

which these new organs have been little by little called into being. At the same time, *here and there* along the line of march, certain forms have been supposed to have "fallen out"—to have ceased to improve; and being happily fitted to the conditions of life in which they were long ago existing, have continued down to the present day to exist in the same low, imperfect condition. It is in this way that the lowest forms of animal life at present existing are usually explained, such as the microscopic animalcules, *Amœbæ* and *Infusoria*. It is in this way that the lower or more simply-made families of higher groups have been generally regarded. The simpler living Mollusca have been supposed necessarily to represent the original forms of the great race of Mollusca. The simpler vertebrates have been supposed necessarily to represent the original vertebrates, and so on.

That this is, to a certain extent, a true explanation of the existence at the present day of *low* forms of animals is proved by the fact that we find, in very ancient strata, fossil remains of animals which differ ever so little from particular animals existing at the present day; for instance, the Brachiopods *Lingula* and *Terebratula*, the king-crabs, and the pearly nautilus are found living at the present day, and are also found with no appreciable difference in very ancient strata of the earth's crust, deposited so long ago that most of the present forms of life had not then been brought into existence, whilst other most strange and varied forms occupied their place, and have now for long ages been extinct.

Whilst we are thus justified by the direct testimony of fossil remains in accounting for *some* living forms on the hypothesis that their peculiar conditions of life have been such as to maintain them for an immense period of time *in statu quo* unchanged, *we have no reason for applying this hypothesis, and this only*, to the explanation of all the more imperfectly organized forms of animal or plant life.

It is clearly enough possible for a set of forces such as we sum up under the head "natural selection" to so act on the structure of an organism as to produce one of three results, namely these: to keep it *in statu quo;* to increase the complexity of its structure; or lastly, to diminish the complexity of its structure. We have as possibilities either *balance*, or *elaboration*, or *degeneration*.

Owing, as it seems, to the predisposing influence of the systems of classification in ascending series proceeding steadily upwards from the "lower" or simplest forms to the "higher" or more complex form —systems which were prevalent before the doctrine of transformism had taken firm root in the minds of naturalists—there has been up to the present day an endeavour to explain every existing form of life on the hypothesis that it has been maintained for long ages in a state of balance; or else on the hypothesis that it has been elaborated and is in advance, an improvement upon its ancestors. Only one naturalist — Dr. Dohrn, of Naples—has put forward * the hypothesis of degeneration as capable of wide application to the explanation of existing forms of life; and his arguments in favour of a general application

* 'Der Ursprung der Wirbelthiere und das Princip des Functions-wechsels.' (Leipzig, 1875.)

of this hypothesis have not, Professor Lankester thinks, met with the consideration which they merit.

Naturalists have long recognized what is called *retrogressive metamorphosis* in the case of parasitic animals, and it is the more remarkable that the same hypothesis should not have been applied to the explanation of other simple forms of animals. The hypothesis of degeneration will, it is believed, render most valuable service in pointing out the true relationships of animals which are a puzzle and a mystery when we use exclusively the hypothesis of Balance or Elaboration.

Referring to the lizard-like creatures *Seps* and *Bipes*, which have *lost* the locomotive organs once possessed by their ancestors, it is pointed out that this very partial or local atrophy is not what the author means by Degeneration; but if this atrophy is extended to a variety of important organs, we shall then have a thorough-going instance of it.

*Degeneration* may be defined as a gradual change of the structure in which the organism becomes adapted to *less* varied and *less* complex conditions of life, whilst *elaboration* is a gradual change of structure in which the organism becomes adapted to more and more varied and complex conditions of existence. In elaboration there is a new *expression* of form, corresponding to new perfection of work in the animal machine. In degeneration there is *suppression* of form, corresponding to the cessation of work. Elaboration of some one organ *may* be a necessary accompaniment of degeneration in all the others. In fact, this is very generally the case; and it is only when the total result of the elaboration of some organs and the degeneration of others is such as to leave the whole animal in a *lower* condition—that is, fitted to less complex action and reaction in regard to its surroundings than was the ancestral form with which we are comparing it (either actually or in imagination)—that we speak of that animal as an instance of degeneration.

Any new set of conditions occurring to an animal which render its food and safety very easily attained, seem to lead as a rule to degeneration; just as an active, healthy man sometimes degenerates when he becomes suddenly possessed of a fortune. The habit of parasitism clearly acts upon animal organization in this way. Let the parasitic life once be secured, and away go legs, jaws, eyes, and ears. The active, highly-gifted crab, insect, or annelid may become a mere sac, absorbing nourishment and laying eggs.

Some examples of undeniably degenerate animals are examined, amongst which are *Sacculina*, which infests hermit-crabs, and from its young (nauplius) stage with legs, has become a mere sac filled with eggs, and absorbing nourishment by root-like processes; *Lernæocera*, the parasite of the gills of fishes, which has lost the well-developed legs of its early stage and become a worm-like creature; the cirrhipedes (barnacles), the mites, and the ascidians.

Special attention is given to the latter, the author's object being to show that their structure and life-history may be best explained on the hypothesis that they are instances of degeneration, and in fact are degenerate vertebrates, as the barnacles are degenerate crustaceans. The identity of the tadpole of the ascidian and the tadpole of the frog is illustrated by figures representing the external appearance and the chief internal organs, together with others, showing how the degeneration proceeds which the ascidian tadpole has to go through to arrive at the adult structure.

The chief causes of structural degradation are (1) parasitism, (2) fixity or immobility (as in the adult barnacle and ascidian), (3) vegetative nutrition (as in the green Planarian worms), and (4) excessive reduction in size (exemplified in the Rotifers, Ostracoda, and Polyzoa). Where the conditions are present degeneration may be suspected even in the absence of any confirmatory embryological evidence.

Degenerative evolution is not limited to zoology, but is applicable to botany as well, as it clearly offers an explanation of many vegetable phenomena, and is already admitted as the explanation of facts connected with the reproductive process in the higher plants. The yeast-plant is in all probability a degenerate floating form derived from a species of *Mucor*.

**Animal Development.***—Professor Schäfer, in his lectures on Animal Development delivered at the Royal Institution, thus formulates some of the general results arrived at from a consideration of the facts discussed:—

(1) If we compare the processes of development of any two animals, from sponges upwards, we find complete correspondence up to a certain point; from which point they may diverge from one another. This point is sometimes placed near the bottom of the development-scale, sometimes near the top; or it may be in any intermediate position.

(2) Development is essentially localization of function and concomitant or consequent modification of structure; such modification being accompanied by segregation of the cells concerned with the function localized.

(3) The path of development of all the more important of these segregated parts is the same up to a certain point in the development of each segregation. From this point it may, in any animals or group of animals, diverge from the rest, or may remain stationary, whilst in the others specialization and modification progress further.

(4) The various stages or phases of development of an animal, as well as of its specialized parts, are often found to correspond with either permanent or transient conditions of animals lower in the scale.

(5) Since the phases of development of individual animals are often seen to be representations of the permanent conditions which are met with in a series of animals belonging to lower grades of organization, it is impossible not to infer that these successive phases in the development of the individual represent similar phases in the process of formation or development of the race to which the individual belongs.

* 'Quart. Journ. Micr. Sci.,' xx. (1880) p. 202. (Containing the substance of the last two of the twelve lectures.)

To revert to a former simile, we may safely say that the developmental telescope of the individual is the same as that of the race, but with the tubes shortened or shifted one upon another so that in many cases their original order is no longer recognizable. The history of the development, then, of any individual animal from the egg is an abridgment of the history of formation in time of the race; or, to state the matter in as few words as possible, "development represents descent."

We conclude, therefore, that the ancestors of every animal have successively exhibited structural conditions which are represented in a more or less modified form by the successive stages of development of the individual. This is the only logical conclusion to which the study of animal development leads. Modifying slightly the words of Darwin, "to take any other view is to admit that the structure of animals and the history of their development form a mere snare laid to entrap our judgment."

**Colours of Animals.***—Dr. Camerano, in a brief notice of a larger work to be published hereafter, divides colours into *internal* and *external*. In animals the latter have of course the chief importance, and he classifies them morphologically as *Hypodermic* and *Epidermic*, and physiologically as (1) *Useful*, including those which are protective (allowing escape), attractive (to the prey of the animal), deviatory, as the eye-like spots of some insects, which distract attention from vital parts; (2) *Indifferent;* (3) *Rudimental*, the remains of a previous more extensive coloration; (4) *Accidental*, as melanism and albinism, arising out of special circumstances peculiar to the individual.

Passing from the consideration of the nature of some colours, he reviews the condition of the different groups of the animal kingdom in their relation to colour, taking certain species from each as examples. He distinguishes sexual coloration from that which depends on the time of year, &c.

The referees on the paper (Signors Cornalia and De Sanctis) believe that the interpretations of the meaning of the intensity, quality, or position of a colour need further examination in many cases; for though one type of coloration running through several species many perhaps be explicable; yet when several species agreeing in other respects—as volume, habitat, food—are found to differ in the matter of colour, it is difficult to account for the fact on utilitarian principles.

**Organisms in Ice from Stagnant Water.†**—Mr. M. A. Veeder has made microscopical investigations with regard to the purity of ice gathered from stagnant water in canals and ponds. Only those fragments were taken (from the interior of blocks) which appeared clean and transparent to the unassisted eye. On melting them and examining the water thus obtained with various powers up to 900 diameters, bits of vegetable tissues and confervoid growths are

* 'Atti R. Accad. Lincei (Transunt.),' iv. (1880) p. 130.
† 'Am. Nat.,' xiv. (1880) p. 388.

usually recognizable at once. Animalcula were not found in an active state in water from ice that just melted, but upon allowing such water to settle and become warm at the ordinary temperature of a room occupied for living purposes, the sediment deposited is found to contain, after some hours, monads whose movements are easily discernible with a magnifying power of from 200 to 400 diameters. Upon allowing the water to stand still longer, Mr. Veeder found the Confervæ growing thriftily, and in some instances forming clusters or bundles frequented by minute animalcula, the entire appearance in this case being very similar to that presented by the nests occupied by the young of the common *Paramecium* seen in stagnant water.

As the result of these investigations, it appears that freezing does not free water from filth due to the presence of sewage or decaying vegetable matter, and further, that it is probable that the germs from which animalcula are developed, if not the animalcula themselves in a quiescent state, are present in very much of the ice taken from stagnant water, so that the use of such ice in drinking water is hazardous to say the least.

## B. INVERTEBRATA.

**Fertilization of the Ovum.***—Professor Schneider calls attention to his observation in 1873, on *Mesostomum* and *Distomum*, that the nucleus and germinal vesicle become elongated and break up into strands, which ultimately become arranged into a rosette, undergoing further changes. The grouping of the granules of the protoplasm of the cell into a star-shaped form was described in 1847, by Derbés in the sea-urchin's egg, and by Reichert in the sperm-cells of Nematodes, &c., and similar facts by Kowalevsky in 1866. Bütschli's observations on the "directive vesicles" are not beyond criticism. These are really cells, and consist of part of the germinal vesicle with some protoplasm.

Professor Schneider's own recent observations,† carried out on Nematodes, Hirudineæ, and *Asteracanthion rubens*, show that the sperm-nucleus has no existence. He agrees with Fol with regard to *Asteracanthion* in the main. A very small portion of the germinal vesicle is extruded with the directive vesicle; the rest sends out amœboid processes in all directions, which are, however, very difficult to demonstrate. The thickness of the ovum often gives very misleading views of these relations. This diffusion of the substance of the nucleus in the ovum renders it almost impossible for the entering spermatozoon to miss it. The stellate mass described as surrounding the latter at its entrance probably belongs to the germinal vesicle, attracted by the stimulus of the male element. At the cleavage the two stellate masses of the *amphiaster* go to different parts, and then both approach the

* 'Zool. Anzeig.,' iii. (1880) p. 252.

† He observes that he has found acetate of carmine (made by saturating boiling acetic acid of 45 per cent. strength with carmine, and filtering) very useful. It is used either diluted to a 1 per cent. solution or by placing a drop of the original solution under the cover-glass.

cleavage-plane. The ovum, contrary to Bütschli and Hertwig, is entered by the spermatozoon while still in the ovarian follicle, not when in the egg-capsule. In the Nematodes fecundation takes place in the oviduct. In *Asteracanthion rubens* the directive vesicles emerge from the micropyle. At the ends of the thirty or more thin amœboid processes of the germinal vesicle appear transitorily stellate figures. The consequences of fertilization may be carried out in sea-water in immature as well as mature eggs. The formation of embryos does not take place if the egg-membrane has not been sufficiently expanded before segmentation. Healthy embryos may be produced from ova into which as many as eight spermatozoa have penetrated. The spermatozoon and the yolk-membrane are connected by a fine process, even before actual contact takes place; this appears to originate from the former. After the entrance of the spermatozoon a ball of substance appears at the point of entrance; it originates from the yolk, and swells up to a round bead, larger than a directive vesicle. When spermatozoa enter immature eggs, this swelling has the form of a long stripe, whose end branches out stellately: no segmentation takes place in this case.

*Aulostomum* and *Hirudo* require several years for the generative products to arrive at maturity; in *Nephelis* and *Clepsine* this occurs in the spring of the second year. In them all the sperm-cells penetrate to the ova while these are still enclosed in their follicles; in *Nephelis* a ring is formed by them in the middle of the mature part of the ovary. In *Nephelis* they may enter the yolk and continue to move there; they also penetrate and remain under the yolk-membrane, but are absorbed when the albumen is developed, as also in *Aulostomum*, where eight roll about with a screw-like motion in the yolk. In *Nephelis* the germinal vesicle continues to move after fertilization, sending out two or three stars. The germinal vesicle is visible in *Aulostomum* when the ovum leaves the ovary; it then becomes an amphiaster, which is concealed by dark granules.

**Renal Organs of Invertebrata.***—In the course of an interesting essay on this subject, Dr. Krukenberg gives a valuable table to show the character of the renal excretion, and the organ of the animal in which it was found; other columns give the authority and bibliographical references. We can here only cite some of the more interesting of these. In the *Actiniæ* guanin is found in the mesenterial filaments (Carus), and the same compound is in *Porpita* found in a whitish layer on the inferior surface of the mantle (Kölliker). Selenka found no uric acid in the "Cuvierian tubes" of the Holothuroida. Bodies closely allied to xanthin or guanin were found by Sommer in the water-vascular system of *Tænia*. Uric acid has been detected in some Tunicata. The organs of Bojanus have been frequently seen to contain urea or uric acid. In some Arthropoda similar compounds have been found in the excreta or in the fatty bodies, where green glands and Malpighian vessels are absent.

* 'Vergl.-Physiol. Stud.' (Krukenberg), ii. (1880) p. 14.

## Mollusca.

**Phylogeny of the Dibranchiate Cephalopoda.***—In a contribution to this subject, Dr. Brock points out how little has been done since the contributions of Professor Owen, now some forty years old, in aid of our knowledge of the anatomy of the group; embryologists have done their best to unravel some of the problems of development, and it is now necessary to make some attempt at their comparative anatomy.

*Shell.*—It seems to be quite certain that the Octopoda are derived from shell-bearing forms; *Argonauta* has in the young the rudiment of a shell-capsule, and *Cirrhoteuthis*, which is no true Decapod, has an internal shell.

*Musculature.*—The examination of this system is attended with very considerable difficulties; but when done comparatively it exhibits some interesting relations, as the following table will show:—

(1.) I. The median retractores capitis are neither fused with one another, nor with the lateral muscles—*Enoploteuthis.*
II. The median retractors begin to be fused with one another—*Onychoteuthis.*
III. Complete fusion of the median retractors with one another, and partial fusion with the lateral muscles—*Ommastrephes, Sepioteuthis, Loligo.*
IV. Fusion complete—*Sepiola.*
V. Retractors enclosed in a muscular hepatic capsule, which is widely open posteriorly—*Sepia.*
VI. The capsule completely closed, and the depressores infundibuli attached to it—*Octopoda.*

(2.) I. A cephalo-cervical articulation developed; the collaris muscle is inserted into the cervical cartilage—*Œgopsida* (except *Loligopsis*), *Sepioteuthis, Loligo, Sepia.*
II. Articulation lost. The collaris forms a closed ring—*Sepiola.*
III. The infundibular articulation rudimentary or absent; the external layer of the collaris fused with the dorsal portion of the mantle—*Octopoda.*

This table gives evidence of a progress from the simple to the more complex, and of the relations which obtain between some of the Dibranchiata and *Spirula* and *Nautilus;* the latter point is argued out in detail.

With regard to that interesting structure—the valve of the infundibulum—the author points out that it is clear that its loss is an indication of the attainment of a higher stage; but he urges that this loss may have been brought about independently in the Loligopsida and in the Octopoda, and that it does not therefore have any weight in fixing their respective affinities.

The central nervous system of the Dibranchiata appears to be eminently formed on one type; in all Œgopsida the ganglion

* 'Morphol. Jahrbuch,' vi. (1880) p. 185.

brachiale has the same elongated form, as was signalized by Albany Hancock in *Ommastrephes todarus;* the same holds good for the supra-pharyngeal lobe of all the Octopoda. In various parts of the peripheral system stages of differentiation can, on comparison, be made out; the ganglion stellatum, for example, did not apparently belong primarily to the mantle, but lay in the visceral sac whence it sent off nerves to the mantle; this arrangement is still to be seen in *Loligopsis guttata.* From this position two series of changes may occur: the nerve and its ganglion may pass to the mantle, or the pallial nerve may separate from the ganglion. This, seen at its earliest in most of the Œgopsida, is carried further in *O. todarus* and *Sepioteuthis,* till in *Loligo* it is carried to an extreme. Other changes may occur in various other forms, and in the short, compressed body of the Octopoda part of the pallial nerve is very considerably reduced. The commissure between the brachial nerves was found to be simple in all the Decapoda that were examined; in *Cirrhoteuthis* a nerve descends from the brachial nerve to the commissure, while in the rest of the Octopoda the primitive commissure forms a closed ring, connected only by branches with the nerves. After treating of the visceral nerves, different stages in which are described, the author passes to the

*Excretory System.*—In all known Decapod Dibranchiata there are two symmetrically disposed orifices, which appear to be primarily placed in the angle of the branchiæ, and thence to pass more or less upwards and inwards; in the *Nautilus,* in all Œgopsida, and in *Sepioteuthis* the orifices of the urinary sacs are simple and slit-shaped; in the higher Myopsida and in the Octopoda more or less elongated papillæ are there developed; and these papillæ, again, exhibit different stages.

Passing over the water-system and the digestive organs, we come to the ink-bag, which is ontogenetically a part of the hind-gut. From the simple embryonic condition two series of differentiations can be made out; one passes through the Decapoda to *Sepia,* the other through the Octopoda to *Octopus* and *Eledone.* The former is principally effected by changes in size, without any change from the original position. Compared with *Enoploteuthis* and *Sepioteuthis* it is much longer in *Ommastrephes, Loligo,* and *Onychoteuthis;* others have a rudimentary efferent duct. In *Chiroteuthis Veranzi* it is triangular in form; in *Sepiola* it is trilobate. It is in *Sepia* only that this ink-bag becomes connected by a long efferent duct with the anus. In the Octopoda change of position is the first point that we note; the ink-bag tends to pass dorsally behind the diaphragm, and to enter into closer topographical relations with the liver. In *Tremoctopus carenæ* it is smaller, and the duct is shorter than in *T. violaceus.* The heart of the Myopsida appears to be a further development of that of the Œgopsida, while the still more highly differentiated organ of the Octopoda is evidently related to that of the Myopsida; no certain comparison can be made with *Nautilus* or *Spirula.*

Little or no assistance is given by the male generative organs to the resolution of phylogenetic questions; great differences, sufficient to fill more than a page, even when stated in a tabular form, are to be found in the female organs. Dr. Brock sums up his results in the following fashion :—

(1) All typical Œgopsida possess two symmetrical oviducts.

(2) The same is true of all typical Octopoda.

(3) The forms in which one oviduct is wanting (Myopsida) are in all points the most differentiated; so that it follows that the double oviduct is the oldest form of the female generative apparatus, and that all forms with one only have lost the other by reduction of the parts.

The following tables will exhibit the leading differences between some of the most important genera :—

I.

| | Ommastrephes. | Enoploteuthis. | Chiroteuthis. | Loligopsis. | Owenia. |
|---|---|---|---|---|---|
| Nidamental glands | + | 0 | 0 | 0 | 0 |
| Oviducts .. .. | 2 | 2 | 1 | ? | 1 |
| Radula .. .. | Complicated | Simple | ? | ? | ? |
| Anal appendages | Asymmetrical | Symmetrical | Symmetrical | ? | ? |
| Infundibular valve | + | + | 0 | 0 | 0 |
| "Spleen" .. .. | 0 | + | + | ? | ? |

II.

| | Ommastrephes sagittatus. | Onychoteuthis. | Enoploteuthis. |
|---|---|---|---|
| Shell .. .. .. | With phragmocone | With phragmocone | Without phragmocone. |
| Accessory hearts .. | Absent | Developed on the branches of the cephalic and posterior aortæ. | |
| Nidamental glands | + | + | 0 |
| Arms .. .. .. | With suckers | With hooks and suckers | With hooks only. |

One of the next important questions is the meaning of the shell of *Sepia*; in other points—musculature, radula, loss of superior salivary glands, form of liver and of ink-bag, absence of commissure between the ganglia stellata and in the fusion of the accessory nidamental glands—this form appears to be one of the most differentiated of the Decapoda. Why, then, does it retain its shell? In other words, Has *Sepia* been derived from Loligid forms, and had the simple horny shell further developed?—or (2) Did *Sepia* separate very early from the Dibranchiate stem, and get its various other characters independently of the other forms?—or (3) Is *Sepia* the direct descendant of the Belemnites, and have the offshoots each independently lost their calcareous shell? The first hypothesis is opposed by palæontology; no evidence supports the second. The third view is the most satisfactory, inasmuch as it seems the Decapoda exhibit a marked tendency to lose their shell, while Spirula, with its still older shell, is probably an example of a form which did early separate itself from the common stock.

The next point discussed is one of considerable difficulty; it is the relations of the Octopoda to the two other groups. The high and exceedingly peculiar organization of the Octopoda seems almost certainly to point to their isolation for a long period of time, or, in other words, to their derivation from some other group than the Myopsida. When we examine the Loligopsis-group of the Œgopsida, we find that they alone among the Decapoda present some of the peculiarities of the Octopod organization—the absence, namely, of a valve to the funnel, the presence of a well-developed spleen, and the rudimentary apparatus for closing the mantle. As we may suppose that the primitive Dibranchiata possessed certain arrangements, such as the fusion of the supra-pharyngeal ganglion with the cerebrum, &c., which are now only seen in the *Nautilus* and in the Octopoda—it seems allowable to suppose that these creatures were separated into two sets, one of which diverged into the Ommastrephida, and the other into the common stem-form of the Loligopsida and Octopoda. This view has its objections.

To sum up: it seems clear that the Dibranchiate Cephalopoda may be divided into three distinct phyla. The oldest are the Œgopsida; the two others—the Myopsida and the Octopoda—have a closer genealogical relation to one another. The Œgopsida may be divided into two groups—the Ommastrephida and the Loligopsida. It is probable that the Œgopsid forms passed through a Belemnite stage to the Sepias, and that the Decapoda with horny shells diverged as independent branches at different times. The Octopoda, or most differentiated forms, have evident points of relationship to the Loligopsida; this derivation may not have been altogether simple.

The parallelism in mode of development of the groups is very striking; it is best shown in the tendency to reduce and lose the shell. In the oldest phylum we find the phragmocone, or a simple horny shell; in the Myopsida we have *Sepiola* and *Rossia*, with a shell only half the length of the animal. *Cirrhoteuthis*, an old Octopod, has a distinct internal shell; but in the more developed forms, not only is the shell lost, but is typically so.

The long essay ends with a discussion on the general bearing of the facts detailed on the doctrine of descent.

**Aptychi of Ammonites.**—In the dwelling-chamber of Ammonites is sometimes found a remarkable body—the aptychus—resembling a bivalve shell widely opened. Very various opinions have been held about these bodies; some considering them to be the opercula of the Ammonites, whilst Pictet avowed that it was difficult to pronounce upon their true affinities.*

Mr. C. Moore has already challenged the correctness of the operculum view, and in a further paper † he shows as the result of

* For a summary of the views of English and foreign observers, with references, see "The Lias Ammonites," T. Wright, 'Palæontographical Soc.,' xxxiv. (1880) p. 182.

† 'Rept. Brit. Assoc.,' 1879, p. 341.

minute examinations of different forms, that in every instance the aptychi were almost entirely cellular, and lines of cell-tubes were extracted from them, differing in scarcely any respect from the egg-packets lying amidst the scattered eggs on the *Ammonites serpentinus* of the upper lias. The facts he has collected are, he thinks, scarcely consistent with the idea that the aptychus was simply an operculum, but on the contrary tend to the conclusion that—possibly with the siphuncular tube—it is an ovarian sac.

**Development of the Pulmonate Gasteropoda.**—The conclusion of M. Fol's essay on this subject, to the introductory portion of which we have already directed attention,* deals with certain theoretical points of some importance.

*Velum.*—This larval structure, which is found in so many different animals, generally takes the form of an ectodermal thickening, covered with vibratile cilia of a particularly large size; it is generally circular in shape, and is placed at the level of the mouth, and, as a rule, a little above the buccal orifice. In most of the sea-dwelling Mollusca it becomes very large; thus, the superior extremity of the larva becomes an enormous sinus, which is filled by the liquid of the body-cavity, and is also provided with muscular fibres. On the other hand, the Pulmonate Gasteropoda have the velum very small and even rudimentary; the thickening is not continuous and circular, but is only developed at the sides; it is, nevertheless, provided with branching contractile cells, which are only found in the higher of the marine forms; so that, in these land-dwelling snails the velum is a structure derived from and reduced from the more complicated forms. But the process of reduction has not been uniform; the "vibratile welt" has undergone more diminution than have the sinus and the muscular fibres, and that although these are not the essential parts of the velum.

Hand in hand with this change in structure, it is evident that there has been some change in function; the primitive duty of the velum was that of a locomotor organ, to which there was added on the function of seizing nutriment; in the Pulmonate forms this larval structure has the function of circulating the nutrient fluid.

The larval heart affords some difficulties; in form and structure it closely resembles that of *Buccinum* and *Purpura;* but it differs in position, for they are primitively dorsal, whereas that of *Helix* only gradually leaves a ventral position; we require further information before we can say whether the explanation of this difference is to be found in the fact that the just-mentioned forms leave the shell at a later period in development, or, whether they have their heart and pallial cavity primitively placed on the ventral surface.

By most authors the symmetry of the body has been ascribed to the folding round of the shell; Ihering, however, regards the torsion of the shell as due to the asymmetry of the viscera. M. Fol regards both these opinions as too extreme; he himself has already shown that in the Heteropoda asymmetrical arrangements manifest themselves at an extremely early period.

* See *ante*, p. 414.

In *Helix* and *Limax* the torsion does not appear so early, and is seen simultaneously in the viscera and in the shell. To explain the phenomena it seems to be necessary to note the process of segmentation of the ovum; but here unfortunately there is but little information. The fact that organs like the kidneys, which are, as we know, primarily double, are in the youngest of Gasteropod larvæ single, seems to show that the asymmetry is produced prior to the commencement of the embryonic period.

*Stomach and Liver.*—Here the author directs particular attention to the mode by which the organs are differentiated from the embryonic digestive cavity. It is, in the first place, necessary to make a fundamental distinction between the case where the cells of the endoderm possess from the first a deposit of nourishment, which comes to them from the yolk—protolecithin—and that where they borrow from the yolk swallowed by the larva, an amount of nourishment which may be called deuterolecithin. The former does not increase during the period of development, and tends to diminish; the latter appears during that period and is rapidly absorbed. The former appears under the guise of globules, which are generally small; the latter is formed into compact and relatively large masses, and is not, or need not be, altogether derived from the yolk.

The Thecosomatous Pteropoda afford an example of the complete absence of deuterolecithin; while in *Firoloides* there is but little protolecithin, and what there is, is rapidly absorbed. In the Gasteropoda the embryonic digestive cavity is bounded in part by an endoderm in which the cells are of the ordinary size, and in part by some very large spherules, which are crammed with the protolecithin; the small cells of the endoderm so grow as to shut off the large spherules from their connection with the digestive cavity, and these thus fall into the body-cavity, where they are simply absorbed. Meanwhile the small cells become charged with deuterolecithin; which, after a time, disappears from that part of the wall which becomes the stomach and intestine; the rest forms a pouch which develops into the liver. These facts seem to show that that view is incorrect, which regards the deposition of deuterolecithin as a mere episode in the development of the liver; this compound is often absent from the rudiment of the liver, and is, on the other hand, often found in structures, such as the ectodermal tissues of the larval *Helix*, which have no relation to that organ.

*Nerve-ganglia.*—These structures appear to arise by somewhat different processes: thus, Fol himself has observed that in the Pteropoda the cerebral ganglia are formed by an invagination of the ectoderm, while in the Heteropoda there is a division of the same primitive layer. Bobretzky has found that these ganglia are in the Prosobranchiata formed by a condensation of tissue in the mesoderm; in the aquatic Pulmonata, Fol has observed a somewhat similar process, save that the mesoderm appears to have been derived directly from the ectoderm; in the terrestrial forms he has seen an ectodermic invagination which was just as well marked as in the Pteropoda.

The auditory and optic organs exhibit a very similar diversity; the Heteropoda, Prosobranchiata, and terrestrial Pulmonata have their otocysts formed by an invagination of the ectoderm, while there is a delamination of the layer in the Pteropoda and aquatic Pulmonata.

The pedal ganglia, on the other hand, exhibit a remarkable constancy in their mode of development; they are always formed in the midst of a pre-existing mesodermal tissue, and can, therefore, only be said to be indirectly ectodermal in origin.

These general considerations lead to still wider generalizations; rejecting the view of Bobretzky that the mode of development must be the same throughout any one phylum, M. Fol states his belief that the identity of embryonic processes is not to be assumed but is to be demonstrated; and, looking at all the facts, he comes to the conclusion that the processes of invagination and of delamination may be derived from one another, and that they have not the importance which is often attributed to them.

*Renal Glands.*—The Pulmonate Gasteropoda are interesting as being provided with a larval kidney, which among the Mollusca has as yet been only observed in *Paludina* and in a marine Prosobranch; paired, it is evidently of the same category as the segmental organs of the Vermes; the permanent kidney is unilateral, it is never developed along the median, but always on the side on which growth is predominant. The larval and permanent kidneys are very similar in structure, but they differ from one another in the fact that the inner pore of the larval kidney opens into the body-cavity, while that of the permanent one opens into the pericardium; this is not, however, a difference of prime importance. A more important question relates to the "typical" presence of two pairs of renal glands in the Mollusca, but this is a question which cannot yet be answered.

*General Homologies of the Larval Pulmonata.*—The Pteropoda appear to be those of the Cephalophora which have most completely retained, in their larval stage, the velum so common among the Vermes; they, too, have the cerebral ganglia most directly derived from the ectoderm. In these, and some other points, the Pulmonata are the most divergent of the Cephalophorous Mollusca. So far as the digestive tract is concerned, they are only remarkable for the great quantity of deuterolecithin. The larval kidneys do not find their representative in the larvæ of the Annelids or of *Polygordius*, but the permanent pair (for paired they really are) completely corresponds in position and structure to the excretory organs of the Rotifera and to the first pair in the larva of *Polygordius*.

It is impossible to compare the molluscan larva with a segmented worm-larva; they only correspond to the cephalic portion of the larva of an Annelid, or to an entire Rotifer; the Mollusca are not segmented animals which have fused their metameres, but they are animals which have remained simple.

In conclusion, the author points out how recent observations tend to favour the re-establishment of the *Vermes* of Linnæus; the larval form (Lovenian, veliger, trochophore) can, with variations in form, be traced through "worms," Annelids, Bryozoa, Brachiopods, and even Echinoderms, and these all form a phylum distinct from that of the

Arthropoda on the one hand, and of the Chordata (Tunicata and Vertebrata) on the other.

**Generative Organs of the Young Helix aspersa.***—M. Jourdain has made some interesting observations on this subject, which are of value from the wide view which the author has taken; none who have been engaged with these organs will be sorry to hear of M. Jourdain's attempt to "préciser la terminologie," and in the presence of so many different modes of stating observations, it will not be useless to detail our author's synonymy of the chief parts of this somewhat complex apparatus:—

| | |
|---|---|
| Hermaphrodite gland .. | Ovary; testicle; racemose gland. |
| Efferent duct of hermaphrodite gland .. .. | Oviduct; primary oviduct; efferent canal; fallopian tube and vas deferens (both invaginated); efferent canal of the hermaphrodite gland. |
| Albuminiparous gland .. | Roe; testicle; ovary; "glaire"; muciparous gland; uterine gland. |
| Copulatory pouch .. .. | Pedunculated vesicle; urinary bladder; receptaculum seminis. |
| Muciparous glands .. | Multifid vesicles; multifid prostate. |
| Genital vestibule .. .. | Genital cloaca. |
| Spermatophore .. .. | Capreolus. |

Young specimens of *H. aspersa* are very far from exhibiting all these, with other, parts; in them, the hermaphrodite gland is composed of a small number of follicles, and they give off an efferent canal, with a straight course; this rapidly increases in diameter and divides lengthwise into an efferent and an ovigerous demi-canal; the former exhibits as yet no indications of a prostate, the latter has on it the rudiments of the albuminiparous glands; the two tubes soon separate and the efferent duct becomes a complete canal; as soon as this is effected this latter forms a loop which gradually grows out to form the penis. The flagellum is not yet developed; there is no dart-sac, and as yet there are no muciparous glands. These last are in time derived from two small diverticula which are developed at the base of the oviduct, and the differences observed in different species are merely due to differences in the growth of these parts; thus, if one is absorbed we find the single muciparous gland of *H. obvoluta;* when they are both developed but remain undivided, we have the form found in *H. cornea* and others; when one bud subdivides, we have the arrangement found in *H. Rangiana*, and so on to the extreme form of *H. pomatia.*

**Gasteropoda from the Troas.**†—In giving a list of the comparatively large number of forms brought home by Professor Virchow, Von Martens points out that all the species are now to be found living in the Mediterranean; speaking generally, they exhibit no differences as compared with more modern forms. Those not used for the production of purple were, for the most part, probably used for food, as are many of the same species at the present time.

**Gasteropoda from the Auckland Islands.**‡—In giving a note on the specimens collected in these islands, the same zoologist describes

* 'Rev. Sci. Nat.,' i. (1880) p. 449.

† 'SB. Ges. naturf. Freunde,' Berlin, 1879, p. 86. ‡ Ibid., p. 37.

a new species of *Mesoderma*—*M. aucklandicum*—which is somewhat similar to *M. novæ-zealandiæ*. He further points out that in its black coloration *Trochus nigerrimus* brings to mind allied species from the South African and South American seas, while the green, at its base, reminds one of the Chinese form, *T. argyrostomus*.

### Molluscoida.

**Marine Polyzoa.***—The Rev. T. Hincks has commenced a series of papers in which he proposes to describe and figure a large number of marine Polyzoa from various parts of the world which have hitherto escaped notice, and thus to offer a contribution towards that general history of the class which still remains to be written.

It is not intended to be confined to bare diagnosis, and the following points especially will receive elucidation:—(1) Geographical distribution—any new localities for known species will be recorded; (2) local variation—the differences exhibited by the same type under differing circumstances will be noted whenever the opportunity presents itself of comparing specimens of the same species from various parts of the world; (3) the limits of variability in each case, and the elements of structure most liable to variation; (4) the true principles of classification. With the descriptions of new forms will be combined notes on such as are little known or misunderstood; and, so far as space will permit, in the case of each genus the number of species already ranked under it will be indicated and its geographical range. These papers will therefore serve as an index to the foreign species which have already been described, as well as an introduction to many that are new. The classification employed will be that of the author's 'History of the British Marine Polyzoa,' so far as it applies, and with such modification as may be suggested by an increased knowledge of the morphology of the tribe. A bibliographical list will be appended containing the principal faunistic and other works which deal with the foreign species.

The series commences with some Madeiran Polyzoa collected by Mr. J. Y. Johnson, and six new species are described and figured. This is followed by descriptions and figures of other specimens from Australia and elsewhere, including eleven new species and one new genus (*Siphonoporella*).

**Fresh-water Polyzoa.**†—The ovum of *Alcyonella fungosa* is composed, according to W. Reinhardt, of transparent granular protoplasm, and has a large clear nucleus and a nucleolus. Later, but while the nucleus and nucleolus are still distinguishable, appear at the periphery uniform, refracting lumps—those described as cells by Allman. Generally only one of the ova in the ovary develops. The nucleus enlarges so much as to touch the margin of the denser protoplasm; it contains a delicate protoplasmic network. The spermatozoon consists of a strongly refringent substance enveloped by a membrane; its head is round, but ends in a point, and is separated by

* 'Ann. and Mag. Nat. Hist.,' vi. (1880) p. 69.
† 'Zool. Anzeig.,' iii. (1880) pp. 208, 234.

a septum from the tail which is purely protoplasmic; it originates from a nucleolus which is similarly refringent. On becoming attached to the ovum its central part contracts into a lump on which the head rests, and the whole becomes covered by a membrane proceeding from the side of the head. After segmentation the mass is converted into a gastrula by invagination; the gastrula-mouth closes and the segmentation cavity disappears, and a ring-shaped depression appears in front enclosing a space which becomes the wall of the future cystid. Three layers are now present in the body; the outer layer, the *tunica muscularis*, and the entoderm. The cells of the ring or "cap" lengthen and become connected with fibres; the polypides which develop within it push out the external membrane round them; the cilia of this membrane cease moving, and its layers of cells unite and then break up into long homogeneous separate cells; in many cases this mass of cells forms a long process at the side of the cystid, and sometimes even increases in size; its further development was not observed, but after a time it was seen to be absorbed into the cystid; it probably represents the stolon of marine Polyzoa.

The structure taken for an oœcium by Nitsche and Metschnikoff appears to be an extension of the ovarian membrane, with which it corresponds in position, in its unilaminar structure, and in containing embryos in stages too early for their emergence. By the formation of the embryo, the polypides adjoining it appear to be destroyed and to form the "brown bodies"; through the openings left by their disappearance the embryo issues forth; the statoblast originates in the same way, and also at the expense of the aborted polypides. The digestive canal is developed from the internal layer of the capsule which encloses the embryo, and not from a specially separated group of cells, as Hatschek states.

With regard to *Cristatella mucedo*, the author gives the following preliminary account of the development:—

The cystid consists, as in *Alcyonella*, of an ectoderm, a median layer (the tunica muscularis), and an entoderm. Thus Hatschek must be wrong when he names the inner layer of the bud, mesoderm; and his description of the budding is inexplicable by comparison with the above-mentioned details, though these may perhaps correspond with his second, unknown, process of budding. The bud develops by a thickening of the ectoderm into which the entodermic cells are pushed; there is no indentation of the former. The tunica muscularis is very early formed; the cavity of the tentacle-sheath is separated later from the alimentary canal, and the lophophore is formed by an invagination into this tentacle-sheath. The later development of the buds corresponds with that described by Nitsche in *Alcyonella*. The statoblasts consist of a uniform granular mass, covered with the cylindrical cells of the ectoderm, under which cells lies a layer of nuclei; the layers increase in number, the tunica muscularis appearing first; the entoderm was hid by the opacity of the central mass.

The well-known concerted movements of the colony are explained by the structure of the common base, which contains suckers formed by invaginations, broad internally, drawn out externally into necks; these suckers are arranged in rows at right angles to the axis of the colony.

Larva of Bowerbankia.*—By way of correction of and supplement to his previous papers on *Bowerbankia*,† W. Repiachoff says that the part there described as a mouth and commented on as being exactly opposite in position to the mouth of the Chilostomata does not lead into the digestive cavity at all, but is simply a ciliated depression of the epithelium, and has no morphological connection with the chilostomatous mouth. The organization of the larva is now seen to be more complicated than was previously stated; the external epithelium is lined on its inner face by a connective-tissue layer, specially thickened at certain points: in the body proper is found a mass of cells considered to be the homologue of the glandular intestinal layer: at the lower part of the body occurs a paired mass of pear-shaped cells which stain deeply with carmine, indigo-carmine, and hæmatoxylin, and are regarded as representing the "cement glands" of the *Entoprocta*.

Euktiminaria ducalis.‡—The Rev. J. E. Tenison-Woods recently described § what he considered to be a new genus of Polyzoa under the above name, and mentioned that similar fossils had been found in the chalk, and that M. d'Orbigny had suggested that they were *Comatulæ* without arms. The author is now convinced that this explanation of these bodies is the correct one. They are the central disks of some unknown species of *Comatulæ*, and he has seen a central disk of an undescribed species, which though much smaller and with very much fewer pores, yet is so similar in all other respects that he does not doubt that *Euktiminaria ducalis*, the *Glenotremites paradoxus* of Goldfuss, and the *Decamerus mysticus* of Hagenow, are all central disks of *Comatulæ*. The central pores on each of these organisms which bear so close a resemblance to the cells of Polyzoa are doubtless connected with the water circulation, like the madreporiform bodies in the Echinodermata. They are not present in all the *Comatulæ*, at least in this form.

## Arthropoda.

Nervous Collars of Arthropods.‖—M. Liénard gives diagrammatic figures of the œsophageal rings of *Cossus ligniperda*, eight other Hexapods, and two Myriopods. He has studied more than sixty genera of Arthropods, whose nervous collars he arranges under four types.

1. *Type of Crustacea.*—Œsophageal connectives ( = longitudinal commissures) very long; transverse commissure straight, at some distance in front of the sub-œsophageal ganglion: Crustaceans (except Isopods), Myriopods (*Glomeris limbata*) and Hexapods (*Gryllus cam-*

* 'Zool. Anzeig.,' iii. (1880) p. 260.
† Ibid, ii. (1879) p. 660, and i. (1878), No. 10. See *ante*, p. 238.
‡ 'Proc. Linn. Soc. N. S. Wales,' iv. (1880) p. 310.
§ See this Journal, ii. (1879) p. 707.
‖ 'Arch. de Biologie,' i. (1880) pp. 381–391 (1 plate).

*pestris*, *Blaps mortisaga*, *Necrophorus vestigator*, *N. germanicus*, *Pieris brassicæ* (caterpillar), *Periplaneta orientalis*).

2. *Type of Dytiscus.*—Connectives extremely short; transverse commissure apposed to, but independent of, the sub-œsophageal ganglion: wood-lice, dragon-flies, Phryganea, and various beetles.

3. *Type of Cossus ligniperda* (first described by Lyonnet).—Connectives of variable length; transverse commissure springing from the supra-œsophageal ganglion, together with or on the inner side of the connectives, and closely embracing the gullet under the form of a vertical sling or loop: various Myriopods, caterpillars, Orthoptera, Coleoptera, and the larva of *Tenthredo*.

4. *Type of Suctorial Hexapods.* — Connectives very short and stout; transverse commissure under one perineurium with the sub-œsophageal mass: Hemiptera, adult Lepidoptera, and Diptera.

Adult Hymenoptera did not give satisfactory results. Arachnids remain to be examined. In Crustaceans it is known that the transverse commissure passes on either side into a small ganglionic mass from which fibres proceed to the brain. Similar centres, save that they are closer to the brain, occur in Myriopods and Hexapods, as shown by Leydig for *Dytiscus*. This commissure has, therefore, no direct relation with the lateral " connectives." M. Liénard hopes to show, in a future paper, the fundamental unity of arrangement of the cephalic nervous centres throughout the Arthropoda.

### α. Insecta.

**Nerve-endings in Muscles of Insects.***—Dr. Foettinger asserts, with Engelmann, the direct continuity of nerve and muscle. He examined various beetles, caterpillars, and the cockroach. For his modes of preparing these subjects we must refer to the original paper. His researches were carried on in the laboratories of Professors E. Van Beneden and Engelmann.

The presence of a nervous network within the proper substance of the muscle-cylinders is here denied. Each muscular fibre has usually several nerve-end organs, or mounds of Doyère, beneath the sarcolemma. Thus, *Hydrophilus piceus* may have six. *Chrysomela cærulea* showed nine of Doyère's cones in the space of one millimetre; while in *Passalus glaberrimus* along thrice the same extent of muscle but four or five could be counted. At the summit of Doyère's organ the axis-cylinder divides into a number of fibrils, which, upon reaching the base of the cone, immediately pass into the muscular substance at the level of the intermediate disks. In this sense Dr. Foettinger modifies the hypothesis of Engelmann (who saw some of his preparations) as to the connection between the ultimate nerve-fibrils and the isotropic bands. One nerve may bifurcate to supply two of Doyère's cones. From the apex of each of these as many as seven fibrils sometimes diverge. The fibrils often seem to pass through the substance of the cone, at some distance from its surface, and a like striated appearance is shown by cones which have been broken

* 'Arch. de Biologie,' i. (1880) pp. 279–304 (1 plate).

across,—facts which cause the observer to conclude that the striæ are true fibrils, and not mere folds of sarcolemma. The author also found several planes of fibrils within a single cone. In other cases the fibrils, injured probably by reagents, were replaced by rows of granules.

The author maintains, against Ranvier, the normal occurrence of true muscular waves. In the passage from the state of repose to that of complete contraction several phases may be observed. First, the intermediate disks (= Zwischenscheiben) and the accessory disks (= Nebenscheiben) become less and less distinct, then quite disappear; the borders of the transverse disks (= Querscheiben) are gradually obscured and form two black streaks (Contractionscheiben of Nasse) limiting the isotropic substance; the clear median disk (= Mittelscheibe) slowly retires from view and is replaced by an obscure line, which during further contraction vanishes in its turn. The "Contractionscheiben," formed by the two primitive anisotropic disks, approach and fuse into a single dark disk. In full contraction alternating dark and clear disks can alone be seen. The contractions which begin in the regions supplied by Doyère's cones proceed in opposite directions along the intervening portions of the muscular fibre.

**Habits of Ants.**—Sir John Lubbock has laid before the Linnean Society * the results of his further observations on this subject.

The paper commences by an account of fresh experiments on the powers of communication of ants. Among others, a dead bluebottle fly was pinned down, and after vain efforts at removal the selected ant hied home, and emerged with friends who slowly, and evidently incredulously, followed their guide. The latter starting off at a great pace distanced them, and they returned, again, however, to be informed, come out, and at length be coaxed to the prey. In the several experiments with different species of ants and under varied circumstances, these seem to indicate the possession by ants of something approaching language. It is impossible to doubt that the friends were brought out by the first ant, and as she returned empty-handed to the nest the others cannot have been induced to follow merely by observing her proceedings. Hence the conclusion that they possess the power of requesting their friends to come and help them.

For other experiments testing the recognition of relations, although the old ants had absolutely never seen the young ones until the moment, some days after arriving at maturity, that they were introduced into the nest, yet in all cases they were undoubtedly recognized as belonging to the community. It would seem, therefore, to be established that the recognition of ants is not personal and individual, and that their harmony is not due to the fact that each ant is acquainted with every other member of the community. It would further appear from the fact that they recognize their friends even when intoxicated, and that they know the young born in their own nest, even when they have been brought out of the chrysalis by

* June 17.—Not yet published.

strangers, indicating, therefore, that the recognition is not effected by means of any sign or password.

With regard to workers breeding, the additional evidence tends to confirm previously advanced views, that when workers lay eggs males are always the issue of these. Without entering into details of instances, it may broadly be affirmed that in the queenless nests males have been produced, and in not a single case has a worker laid eggs which have produced a female, either a queen or a worker. On the contrary, in nests possessing a queen, workers have been abundantly produced. The inference from these curious physiological facts leads to the presumption that, as in the case of bees, so also in ants, some special food is required to develop the female embryo into a queen.

In Sir John's nests, while from accidents and other causes many ants are lost during the summer months, in winter, nevertheless, there are few deaths. As to the age attained, specimens of *Formica fusca* and *F. sanguinea*, still lively, are now four and others five years old at least.

The behaviour to strange queens often results in their being ruthlessly killed; yet as communities are known to have existed for years, queens must occasionally have been adopted. With the view of trying how far dislike and passion might be assuaged by a formal temporary acquaintance, a queen of *F. fusca* was introduced into a queenless nest, but protected by a wire cage, and after some days the latter removed, but the queen was at once attacked. Mr. McCook, nevertheless, relates an instance of a fertile queen of *Cremastogaster lineolata* having been adopted by a colony of the same species. Such difference in conduct, Sir John suggests, may be due to his own ants having been living in a republic; for it is affirmed that bees long without a queen are strongly averse to adopt or accept another. Furthermore, if a few ants from a strange nest are put along with a queen they do not attack her, and if other ants are by degrees added the throne is ultimately secured.

In pursuance of experiments to test the sense of direction, some ants were trained to go for their food over a wooden bridge made up of segments. Having got accustomed to the way, afterwards when an ant was in the act of crossing, a segment was suddenly reversed in direction, evidently to the ant's discomfiture; she then either turned round, or, after traversing the bridge, would return. When, however, similar pieces of wood were placed between nest and food, and the ant at the middle piece, those at the ends being transposed, the ant was not disconcerted. In other instances a circular paper disk was placed on a paper bridge, and when the ant was on the disk this was revolved, but the ant turned round with the paper. A hat-box with holes of entrance and exit pierced at opposite sides was planted across the line to the food; when the ant had entered and the box was turned round, the ant likewise wheeled about, evidently retaining her sense of direction. Again, with the insect *en route*, when the disk or box with the ant within was merely shifted to the opposite side of the food without being turned round, the ant did not turn round, but continued in what ought to have been the direction to the food, and evidently was surprised at the result on arrival at the spot where the food had previously been.

To ascertain whether ants make sounds audible to one another the use of the telephone was resorted to, but the results were negative. These experiments may not be conclusive, for the plate of the telephone may be too stiff to be set in vibration by any sounds which the ants produced.

As opposed to the opinion expressed by M. Dewitz, Sir J. Lubbock regards the ancestral ant as having been aculeate, and that the rudimentary condition of the sting in *Formica* is due to atrophy, perhaps attributable to disuse.

A ground-plan of the nest of *Lasius niger* is given, which exhibits an intricate, narrow, and winding entrance-passage; the main nest cavity is further supported by pillars, and here and there by islands; protected recesses obtain, evidently strategical retreats in times of danger.

Studying the relations and treatment of the aphides, or plant-lice of the ants, Sir John clearly demonstrates that not only are the aphides kept and protected in the ants' nests, but the eggs of *Aphis* laid outside on the leaf-stalks of its food-plant in October, when exposed to risks of weather, are carefully brought by the ants into their nests, and afterwards tended by them during the long winter months until March, when the young ones are again brought out and placed on the young vegetable shoots. This proves prudential motives, for though our native ants may not lay up such great supplies of winter stores of food as do some of those found abroad, they thus nevertheless take the means to enable them to procure food during the following summer. The fact of European ants not generally laying up abundant stores may be due to the nature of their food. Insects and small animals form portions of their food, and these cannot always be kept fresh. They may also not have learnt the art of building vessels for their honey, probably because their young are not kept in cells like those of the honey-bee, and their pupæ do not construct cocoons like those of the humble-bee. Relatively to their size our English ants nevertheless store proportionally; for if the little brown garden ants be watched milking their aphides, a marked abdominal distension is observable.

The paper concludes with the history and technical description of a new species of Australian honey-ant. This corroborates Westmael's strange account of the Mexican species; certain individual ants being told off as receptacles for food—in short they become literally animated honey-pots.

**Respiratory and Circulatory Apparatus of Dipterous Larvæ.***—The larvæ examined by M. Viallanes appeared to belong to the genus *Ctenophora*. He describes the dorsal vessel of a young larva as a long contractile tube, which is only open at its two extremities. In the last segment of the body there is a median enlargement, and there are two stigmata at its margins which give off two large longitudinal tracheæ.

* 'Comptes Rendus,' xc. (1880) p. 1180.

These, almost at once, give off a number of tracheal branches, which divide but little and terminate in the cavity of the last ring, in which they are so numerous as almost completely to fill it. As the cardiac tube opens widely into this last ring, we find a cavity full of blood and containing an enormous number of tracheæ. The method of action is as follows: when the vessel contracts, the blood is driven into the last ring; here it is easily oxidized; when the posterior end dilates, the blood passes in, and as the entrance is fenced by a trellis-work of tracheæ no blood-corpuscles can escape the influence of the oxygen. Here, then, "the respiratory function is localized in the terminal segment, and the dorsal vessel is an arterial heart."

Some way behind the anterior orifice the dorsal vessel is covered by large cells, for which the author proposes the name of *pericardiac cells;* these become greatly developed and connected with the sides of the body; they thus form the primitive pericardiac sinus. The point of origin of the future lateral orifices is indicated by spots of greater contractility, where the pericardiac cells are not developed.

**Development of the Blepharoceridæ.***—Under the title of 'An Unknown Discovery made by Fritz Müller,' Professor F. Brauer points out that the developmental history of the Dipteran group of *Blepharoceridæ* has hitherto remained unknown, and in consequence its systematic position has been uncertain. He has discovered in an elaborate unpublished work by Fritz Müller, a fly described as new under the name of *Curupira torrentium;* this, however, he identifies with the genera *Paltosoma*, Schiner, and *Hapalothrix*, Low, although the new species is Brazilian and the latter genus is from Monte Rosa.

Now certain Dipteran-nymphs of remarkable structure in the Vienna Museum, and coming from the Tyrol, prove to be exactly like the pupæ assigned by F. Müller to *Curupira.* Their form is a half oval and they are attached to stones by a flat transparent side. On the removal of the insect from its case the venation of the wings was seen to correspond exactly with that of *Blepharocera fasciata* West, showing the secondary vein peculiar to the family. Probably the larvæ of other genera resemble those of F. Müller's species, which must stand as *Paltosoma;* the cephalic organs should be investigated in them to decide whether the family belongs to the Culicidæ or the Tipulidæ; the former appears the more probable, and they much resemble the Simulidæ. The larvæ of *Paltosoma* are woodlouse-shaped, with deep segmental joints; the lower side carries a series of suckers and tracheal gills in the middle line.

**Tracheal System of Larval Libellulidæ.**†—Referring to Dr. Palmén's work upon this subject, Dr. H. Hagen (pointing out that that author has committed some errors of citation, &c.) follows Lyonnet in showing that the stigmata of the larvæ are readily closed in case of necessity. Thus from the stigmata of a living *Æschna*-larva, impaled with a pin which was heated in a flame, a small bubble or bladder was seen protruded; dead pinned specimens

* 'Zool. Anzeig.,' iii. (1880) p. 134. † Ibid., p. 157.

sometimes show circles of dried blood round the stigmatic opening. But the stigmata which are thus shown to open under certain conditions can hardly be closed by any other than mechanical means; for it is impossible that their walls, lined as they are by a continuation of the cuticle, can fuse together as has been stated. The reason that the stigma of the first of the eight abdominal segments is so often overlooked, is that in the exuvium its tracheal branch lies immediately under the longitudinal cord, composed of the aggregated tracheæ; it is smaller in the imago of *Æschna constricta* than in the larva.

A muscular apparatus, at any rate in the second and the other posterior segments of the larvæ, passes backwards and upwards from the stigma in a groove to the internal angle of the segment. The prothoracic stigmata differ from those of the abdomen in having the appearance of an actively used apparatus; a number of large well-developed tracheæ pass directly to the stigma, within the two lips of which their openings—covered by a membrane containing a dense reticulum of quadrangular cells, as in the Perlidæ—are readily to be seen; the commencement of the spiral thread in the form of folds. The mesothoracic stigma is closed by a plate which is externally clothed with hair; in the larva this plate carries epidermis as well, and constitutes the "tympanum" of Oustalet; the tracheæ appear to be functionally active here also, though less so than in the prothoracic. The tissues of the tracheal brancheæ of the rectum are cast off in *Epitheca bimaculata* and *princeps*, and not renewed in the imago—they are 5·5 mm. long in this genus; the same seems to hold with other genera, though it is the exception in *Æschna*.

Although it has been contradicted, the respiration in the larvæ of Calopteryginæ is conducted by a tracheal system distributed in three rings which surround the rectum. The middle foliar gill is supplied by tracheæ. *Euphæa* manifests a still higher development in the possession of long conical organs on both sides, like those of *Sialis*, seen in *E. splendens* and a species from Ceylon. In some larvæ (probably belonging to a new species, to be called *Anisopteryx comes*, from the Himalaya), a long pointed cone of cuticular structure extends along each side of the body from the second to the eighth segment; the caudal branchiæ are inflated and pointed, each inflated mass contains a fat body externally pigmented and supplied richly with tracheæ internally; a tube of similar dark colour and structure extends into the lateral respiratory cone. On the front edge of the eighth external plate in *Epitheca* and *Libellula* occurs an oblique slit ·5 mm. long, leading into a sac in the body which is loosely enveloped by another sac of the shape of a Phrygian cap, and ·5 mm. long by ·5 mm. broad, the inner one being covered with pavement-epithelium; outside this in the articulation fold of the segment is an area covered with similar cells; the external loose sac, like the epidermis of a large tracheal stem, shows rows of fine granules under a high power. Tracheæ were traced to the slit or opening. This apparatus has not been found in the Agrionidæ. It may possibly secrete a lubricating substance for the joints, and perhaps is connected morphologically with the abdominal appendages, which are present in *Euphæa*.

**Remains of Branchiæ in a Libellulid: Smooth Muscle-Fibres in Insects.***—Not only has the larva of *Euphæa*—as described † by Dr. Hagen already—lateral branchiæ, but even the imago has them. They occur as small cuticular processes on the ventral face of every segment; on the second segment they are longer and almost free; in the male they lie beside the genital hooks. Dr. Palmén's assertion to this effect is thus justified. Gills do not occur in the larvæ of *Rhinocypha*; but they occur below the *head* in the Perlid *Dictyopteryx signata*.

A further exception to the conditions obtaining in its congeners is offered by *Euphæa*, in the presence of numerous smooth, unstriped muscle-fibres in its caudal gills; these gills have somewhat the shape of a turnip, and are entirely filled with a pulpy mass consisting of a regular network of sub-hexagonal connective-tissue cells; they contain fat, and each is penetrated by two stout red tracheal vessels. In longitudinal section they exhibit a great number of smooth cross fibres, and also a series at right angles to these. The fibres are arranged thus in the gill, which has a circular outline with the exception of the lower side which forms a right angle; from the apex of this angle proceeds a broad bundle, of which the fibres are somewhat distinct, right and left into the gill; at its middle the fibres are much concentrated; the upper two-thirds of the gill-cavity are devoid of muscles; a number of smaller muscles occur in the lower third with the large ones. The only indication of striation in any of these fibres under an immersion power of upwards of 700 diameters was a fine longitudinal lineation near the point of insertion. The physiological action must be that these muscles by contracting compress the two large tracheal vessels which lie nearly in the centre of each, and drive the oxygenated air from the gill into the body, thus meeting the want of a free circulation of blood in the part, which is due to its being filled up with other tissues; the elasticity of the connective tissue would cause the mass to re-expand.

A cellular network of such regularity as that of this tissue appears never to have been recorded from the body of an insect before. The cells measure about ·08 mm. in diameter, and their wall less than ·0001 mm. in thickness. The longitudinal striation of the proximal end of the muscles must be due to a series of folds allowing of expansion after the air has been driven into the body.

Probably similar arrangements will be found in other Calopteryginæ.

**Metamorphosis of Prosopistoma.**‡—In August 1878, M. A. Vayssière, in conjunction with Dr. E. Joly, published a note on the organization of *Prosopistoma*. Notwithstanding the large number of living individuals they then had at their disposal, they were unable to observe any transformation in these curious insects, and consequently were led to accept the view of Mr. MacLachlan, that *Prosopistoma* is merely an Ephemerid adapted for a permanent aquatic

* 'Zool. Anzeig.,' iii. (1880) p. 304. † See *ante*, p. 617.
‡ 'Comptes Rendus,' xc. (1880) p. 1370.

life. Their anatomical observations, especially those as to the considerable concentration of the nervous system, seemed to confirm that hypothesis.

M. Vayssière considers that this opinion must now be abandoned, as he has just seen the metamorphosis of two of the insects captured in April last.

The following are the principal phases of this metamorphosis:—Towards the end of May the amber-yellow colour of some of the insects became darker; and owing to their transparency he was soon able to see the first outlines of the new individual, and two or three days afterwards the animal cast off its pupal envelope, freeing itself in the same manner as the ordinary Ephemeridæ.

In the perfect state *Prosopistoma* almost exactly resembles *Cœnis;* its last segment is provided with three rudimentary bristles representing the swimming bristles it possessed during its aquatic state. The anatomical modifications brought about by this metamorphosis are reserved for a complete monograph on the genus.

**Piercing Organ of the Lepidopteran Proboscis.***—This organ, which has already been described † by the author, Professor W. Breitenbach, is situated at the end of the proboscis, and is designated by him "liquid-piercer," or "opotrype," and its function is now considered. There are various forms which it assumes, but they all result from the modification of simple hairs. Although a tactile function has not been satisfactorily demonstrated for the hairs of the proboscis by evidence of nervous end-organs in them, yet analogy and their large size lead to such an inference. Turning to those more complex appendages to the proboscis, the barbed hooks, we find that those butterflies which possess them—as *Ophideres* and *Egybolia*—live to a great extent by the juice extracted from the interior of fruits, a process effected by the intrusion of the stout trunk into the rind and its subsequent withdrawal, when the backwardly directed hooks lacerate the tissues and set free a quantity of juice. Direct observation of a similar function in the "liquid-piercer" is not forthcoming; this fact, however, speaks in its favour, namely that on the Alps a number of butterflies are seen to be occupied with flowers which contain no honey, thrusting the trunk into them and remaining thus employed for a time; if this process was really futile, it would soon cease to be repeated; but as it is not, it is probable that liquid is procured by the laceration of the structures by the piercer. The structure of the organ itself supports this assumption; the median point of that of *Vanessa* is admirably adapted to pierce the delicate membrane of a juicy cell, and the lateral points to break up more cells, so that where as many as sixty piercers are present, as in *V. cardui*, the effect would be very great, but only analogous to that already known to be produced by the maxillæ of the humble-bees.

In opposition to this view stands Fritz Müller's opinion that they are "taste-rods"; but to this it is replied that their structure is

* 'Entomol. Nachrichten,' vi. (1880) p. 29.

† See this Journal, ii. (1879) p. 41.

cuticular, not cellular, and that they probably contain no living protoplasm through which sensations of taste could be transmitted; further, the characteristic "taste-cells" are wanting; and this hypothesis fails to explain the presence of the teeth and radial plates. Tactile organs, however, as is the case with the hairs from which they are derived, they might in part be, transmitting to the insect information as to the absence or presence of free honey in any calyx which is investigated.

**Generative Glands and Sexual Products in Bombyx mori.***—A. Tichomirow has made out a distinct central orifice in the epithelial septum which divides the ovarian ovum from the yolk-chamber; through this a granular substance resembling that of the yolk-forming cells is seen to pour into the yolk. The chambers in which the eggs are found after leaving the yolk-forming cells are clothed all over by closely packed epithelial cells between which no spaces occur. Sections show that the epithelium of the yolk-chambers grows thinner as the cells lining the "egg-chambers" grow vertically thicker, these latter form the chorion, each contributing a small plate to it; in far advanced chambers these plates form a continuous cuticle.

The terminal spaces of the ovarian tubes are filled with cells, those near the external membrane small, ultimately becoming the epithelium of the tube, the more central ones are successively larger and become ova and yolk-forming cells. Free nuclei occur in the very last chamber, becoming the nuclei of the epithelium. The ovum and the yolk-cells both increase in size, but the former the quickest and chiefly at the expense of the latter. The testes consist of two sacs penetrated by largely branched tracheæ; they contain large numbers of smaller follicles which vary immensely in their shape and the nature of their contents from the youngest, which are spherical, to pear-shaped, and finally to very elongated forms; in them all, until the spermatozoa are mature, a fragile *tunica propria* is discernible. The testis is enveloped at the proximal end by a fine connective tissue containing fat-cells; at the free end the youngest follicles occur, further down riper ones are found, and finally bunches and single specimens of spermatozoids. The penetration of the tracheæ into the cavity shows that it cannot be lined internally by an epithelium. In a comparison of the structures of the male and female glands, the wall of the testis corresponds to the common envelope of the ovarian tube, but the ovarian tubes are represented by nothing in the testes; the follicles in the latter represent the egg-chambers. The follicles with their contained spermatoblasts are to be regarded as only a part of the contents of the gland; the latter commence as round cells provided with a nucleus and nucleolus, the outline of the nucleus disappears suddenly and a strongly refringent body appears near it; the nucleolus persists when the cell has taken the form of an elongated fibre; the subsequent formation of spermatozoa follows the process described by Bütschli.

* 'Zool. Anzeig.,' iii. (1880) p. 235.

**Development of Forficula.***—L. Camerano has found the eggs of *Forficula auricularia* Linn. at the end of January; a female was found with them. This conflicts with Fischer's statement that the eggs are laid in April, but the case was but a single one, and the preceding fine autumn may have advanced the time of oviposition. On the eggs being scattered about, the female carried them in her mandibles to one place so as to re-form the original heap; her movements were less active when under a good light than otherwise. The egg is ellipsoidal, yellowish white, and somewhat opaque, about 1 mm. in extreme diameter. In the ova gathered in January the embryos were to be seen, with brownish eyes, mandibles, eight-jointed antennæ, and the posterior pincers, prothorax, and abdominal rings superficially punctate; the antennæ, palps, and legs were invested by a pellicle, which appears not to be the future larval skin. At the end of six days from the finding of the eggs the young began to come out (but perhaps unduly early owing to the warmth of the rooms). At this stage they are whitish in colour, have weak legs, but well-developed and motile pincers; after six or seven hours the body begins to assume its brown colour, beginning with the pincers; the legs and lower parts become coloured later. Owing to absorption of air the body rapidly increases in size, and at the end of ten hours from leaving the egg is 3 mm. long, excluding the pincers. Three changes of skin take place; possibly a fourth, anterior to the first observed, may have escaped notice, owing to the habit which the larva has of devouring the old skin at once. The first of these changes occurs when the larva is about 6 mm. long (excluding pincers), the second at 8 mm., the third at 12 mm.

In another instance eggs were laid on March 10th by a female taken in the winter, and the larvæ from them made their first change of skin between March 24th and the 30th; the second change took place on the 15th of April, the third at the beginning of May, and on May 22nd the larvæ became perfect insects. It was noticed that some males of this species appeared to prefer dead insects to fruit as food.

**Actora æstuum from the Shore at Heligoland.**†—This insect, described by Meigen, justifies its name by the locality, namely the surf of the sea, or the seaweed floating near the shore, in which it is found. Dr. Joseph observes that it is very timid, flying off to another part of the wet sand at the slightest noise; it may be covered by a wave but it shortly reappears on the surface, the drops rolling from it as from a sea-bird. This fact is due to a somewhat glistening waxy covering (which splits and falls away in the form of minute scales from time to time) being then renewed; most rapidly so on the wings, halteres, and spiracles. It is produced as a primarily oily substance by small glands scattered over the body, aided by larger tubular ones, resembling the sweat-glands of some mammals, and lying in the connective tissue between the wing-muscles; their ducts open beneath the commencements of the wings and halteres.

* 'Bull. Soc. Entomol. Ital.,' xii. (1880) p. 46.
† 'Zool. Anzeig.,' iii. (1880) p. 250.

The larva resembles that of the common *Scatophaga stercoraria* L., but is larger; it lives in the bladderwrack between high and low-water mark, the periodical wetting with sea-water being necessary, as shown by experiments, to its existence. The pupæ are found from 2 to 3 inches deep in the sand; the imago emerges in from fourteen to eighteen days.

A hymenopterous parasite, resembling *Smicra clavipes*, was observed to issue from the pupa in one case; the egg must have been laid by the female of that species, which is abundant, between the time that the larva left the weed and that at which it entered the sand. The parasite devours the entire interior of the pupa, and emerges in eighteen days.

**Destruction of Noxious Insects by Mould.***—In answering Professor Metschnikoff's remarks on Dr. Bail's discovery of the deadly action of mould on insects, Dr. Hagen remarks that that observer never applied his method to noxious insects, although he was successful with other kinds. He himself has found that potato-beetles took the disease thus engendered, and died in from eight to twelve days; the other half of the same lot of beetles, which were not inoculated, lived through the winter in the same room. He has also killed plant-lice in a hothouse by this means. He cannot agree with Professor Metschnikoff that the discovery cannot be applied to practical uses until its scientific meaning is understood, for the results already show that it is successful in practice, and its success is being further tested by the experiments of many naturalists.

### γ. Arachnida.

**Development of the Araneina.**†—That Mr. Balfour's "notes" on this subject were really wanted is shown by the extremely scanty list of writers who have addressed themselves to the spiders, or to allied forms; the investigations now under consideration were made on the ova of *Agelena labyrinthica*. The embryos were, after the method of Bobretsky, hardened in bichromate of potash, after having been for a short time in nearly boiling water. "They were stained as a whole with hæmatoxylin after the removal of the membranes, and embedded for cutting in coagulated albumen."

*Segmentation of the Ovum.*—When segmentation is complete, the embryo is found to consist of a single layer of large flattened cells, with a central mass of yolk-segments, polygonal in form and made up of a number of clear yolk-spherules; among these yolk-segments we find bodies which consist of a large nucleus, filled with apparent nucleoli, and of a surrounding layer of protoplasm: each nucleated body would seem to belong to a yolk-sphere, and to be placed at one side of it; the nuclei themselves would be derived from the nuclei of the "segmentation rosettes."

In the next stage, which is not far from that of the completed segmentation, the ventral surface of the embryo is distinctly marked; it would appear to be made up of a procephalic lobe, an intermediate

* 'Zool. Anzeig.,' iii. (1880) p. 185.
† 'Quart. Journ. Micr. Sci.,' xx. (1880) p. 167.

portion, and a caudal lobe; the ventral thickening is important, inasmuch as it is the point at which two rows of cells are first developed, and is therefore the first indication of the future mesoderm. The already mentioned intermediate portion consists of three indistinct segments; the first of these appears to be the seat of origin of the first pair of ambulatory limbs. The character of the ventral thickening is to be noted; first, because it shows that in this form, at any rate, the cells are continuous across the middle line, and do not exhibit any bilateral arrangement; and secondly, because it is very similar to the arrangement described by Kowalevsky as obtaining in an insect, and is supported by the observations of Barrois, who has already noted the presence of "a continuous ventral plate of mesoblast."

Shortly after this stage, there is found one in which there are six segments intermediate between the procephalic and caudal lobes; the first two are more indistinct than the succeeding ones, owing probably to their later formation. The increase in segments is regular, and each new one appears between the one last formed and the caudal lobe; the appendages do not begin to appear until some nine or ten segments have been formed, and there is, at this period a distinct median ventral groove; at this stage the procephalic region is "distinctly bilobed," but the first segment is still without appendages ("cheliceræ"); this is in keeping with its late appearance as a segment. Some of the succeeding appendages are indicated by swellings. An imperfect, though distinct, division of the mesoblast into somites is now apparent.

In the next stage the ventral plate extends over nearly the whole circumference of the ovum, the procephalic region is distinctly bilobed, the stomodœum is commencing, each of the six segments behind the lobe bears prominent appendages; and behind these there are four somites with small protuberances. The latter are provisional appendages, and their presence has been already noted by Claparède and Barrois. Just a little later, sixteen post-cephalic segments may be detected.

The epiblast exhibits no less interesting characters; it is very thin along the median groove, but on either side there is well-marked thickening forming the first rudiments of the ventral nerve-ganglia. It is of importance to note that the cheliceræ have a ganglionic thickening *independent of the procephalic lobes.* In these latter the epiblast is much thickened, but this is the part which goes to form the supra-œsophageal ganglia.

Later on, the appendages begin to be jointed, and primitively these joints are five in number; this is, as Mr. Balfour points out, an interesting character, for "this number is permanent in Insects and in *Peripatus.*"

Next, we find that the limbs nearly meet in the middle line; the two-jointed cheliceræ appear to terminate in rudimentary chelæ, and, so far, indicate that the spiders had ancestors with chelate cheliceræ. A large upper and a small lower lip have become developed at the entrance to the stomodœum; the procephalic lobes are distinct, and are divided by a groove into a narrower anterior and a broader posterior portion. What is of considerable value is the observation that a section of the body-cavity is enclosed between the splanchnic and somatic layers of the mesoblast of these lobes. Connecting this with the observations of Kleinenberg on *Lumbricus*, the author points out that the procephalic lobe of the spider represents the præ-oral lobe of the Chætopod larva; "but the prolongation of the body-cavity into it does not necessarily imply that it is equivalent to a post-oral segment." There is not yet any trace of the separation of the ganglionic portion of the epiblast of the lobes from the epidermis.

As the embryo takes on the characters of the adult, the hitherto simple dorsal region begins to be developed, so that there soon appears a ventral instead of a dorsal flexure of the embryo. After a time the heart becomes evident, taking its origin from a solid cord of cells, which are derived from the dorsal mesoblast prior to the differentiation of two strata in this region. About the same time the thickenings of the supra-œsophageal ganglia become separated from the epiblast, and the proctodœum begins to appear.

Other points of interest are described, but our space requires us to pass on to the general conclusions; on the whole the history of development is conclusive as to the closer affinity of the Arachnida to the Tracheata than to the Crustacea (Branchiata). The mesoblast has very much the same history, being in both cases formed by a thickening of the median line of the ventral streak: in the Crustacea the mesoblast is known to be developed from the walls of an invagination. Where mesoblastic somites are found in Crustacea they are not similar to those of the Tracheata. The mesenteron of the Crustacea is formed by an invagination, and the proctodœum appears before or cotemporaneously with the stomodœum; the reverse obtains with the Tracheata, where, too, the mesenteron is not excessively short, nor the proctodœum very long. It is now almost completely certain that the cheliceræ are true post-oral appendages, and it is clear that, just as in *Lumbricus* and *Peripatus*, there is no invagination of epiblast in the region of the ventral nerve-cord.

In a postscript to this paper, which appears on p. 106 of the new 'Studies from the Morphological Laboratory, at Cambridge,' Mr. Balfour states that his attention has been directed to the German abstract of a paper, written in Russian, by Salensky; from this he gathers that that observer has detected the splitting of the mesoblast into splanchnic and somatic layers, and had given a very similar account of the development of the heart. With regard to the provisional abdominal appendages, the final stages of which Mr. Balfour was unable to observe, Salensky found that the anterior pair gave rise to the pulmonary sacs, while he thought that the third and fourth pairs became the spinning mamillæ; the latter view, at any rate, the English observer is inclined to reject.

**Peculiar Modification of a Parasitic Acarian.*** — Amongst a large number of insects parasitic on plants, the female ready to lay

* 'Comptes Rendus,' xc. (1880) p. 1371.

or to give birth to larvæ often covers herself with a cottony or byssoid secretion, which serves not only to protect herself, but also to preserve the young during the early periods of life. Certain Arachnids, also parasitic on plants, have the same power; and a species of *Tetranychus* has for that reason been named *T. telarius*. In this case the cottony secretion constitutes a true nidification destined to protect the eggs, as the female lays successively in several nests.

Hitherto nothing similar had been observed amongst the Acarians parasitic on animals; but M. Mégnin has now found by accident an exactly similar fact in the parasite of a bird. In dissecting an American Grosbeak he was struck by the presence of numerous white spots strewn over the naked median and sternal portion of the skin covering the lower surface of the breast. Viewed with a lens they appeared like spots of mould; but under the Microscope, especially after soaking them in glycerine, which rendered them diaphanous, these spots proved to consist of a fine tissue, under which appeared a group of eggs in different stages of incubation, of empty egg-shells, and of small yellow Acarians just hatched. These Acarians are but octopodal larvæ, which it is easy to recognize by the anatomical characters of their rostrum and legs as belonging to the species named by the author *Cheyletus heteropalpus*.*

Professor Ch. Robin† has shown that the plumicolous Sarcoptides lay their eggs in small masses at the axils of the barbs of the feathers; and M. Mégnin thought that his parasitic Cheyletidæ did the same, though he had never found their eggs together.

The foregoing observations show how these eggs, which are very large (·18 mm. × ·11 mm.), are laid, and what precautions the animals take to protect them, a fact which brings them singularly near the *Tetranychi*, with which they are besides so closely allied in organization; they show, moreover, that the larvæ of this species are octopod at birth, a character not possessed by those of the *Tetranychi*, nor even by those of the wandering Cheyletides, such as *Cheyletus eruditus*.

**Structure of Trombidium.**‡—The results of A. Croneberg's investigations lead him to believe in a closer connection between this genus and the Hydrachnidæ than would appear from Pagenstecher's monograph of the genus. His study of *T. holosericeum* shows that the cuticle consists of an external layer, traversed by pores and carrying the hairs, and of a thin fenestrated inner layer. The hypodermis is granular, semi-fluid in life; no cell-structure can be discovered in it.

*Digestive Organs.*—The labium presents a deep groove, open in front. Posteriorly, its halves are united by a cross-piece, from each side of which a narrow piece runs backwards along the upper edge of the maxilla, representing the "supra-œsophageal ridges" of *Hydrachna globosa*. Closely connected with the cross-piece are two chitinous tubes, which project backwards and enclose the posterior three-quarters of the two great tracheal vessels, the anterior part of these being left,

* 'Journ. Anat. et Physiol.' (Robin), 1878.
† 'Comptes Rendus,' Apr. 30, 1868.
‡ 'Bull. Soc. Imp. Nat. Moscow,' liv (1879) p. 234

as also in the Hydrachnidæ, uncovered by the tubes. These structures are represented in *Eylais* by two long rods, which enclose the tracheæ for a short distance. Two ridges projecting forwards from the cross-piece enclose the mouth, as in *Hydrachna;* behind this the pharynx, which consists of a chitinous groove roofed in above by a lamina of intrinsic and extrinsic muscles, passes backwards within the labium, exactly as in *Hydrachna.* An œsophagus of the same diameter (0·25 mm.) traverses the main nervous mass, after rising up; it enters the lower part of the anterior end of the stomach, thus differing from Pagenstecher's description, but agreeing with *Hydrachna* again. The stomach's upper surface presents symmetrically arranged lobes, through the spaces between which the vertical body-muscles pass; the excretory organ, which has been called a fat body, can be just seen in the median line. The cæcal lobes consist of a *membrana propria*, lined internally by a thick granular layer containing granular vesicles, but no trace of cell-structure. A similar structure characterizes the stomach-walls, so that Pagenstecher's description of cells here, and his consequent interpretation of the organ as a liver, prove erroneous. Probably it has a double function, the biliary secretion being supplied by the brown cells and the granular investing substance, in Hydrachnidæ. Possibly the non-cellular mass of *Trombidium* represents a stage in the breaking down of these liver cells. There is no direct connection between the stomach and anus. The posterior end of the excretory organ, which has been mistaken for such a connection, is distinguishable by its chalky-white contents; it has two anterior branches, and contracts posteriorly towards the anus; no lining epithelium was made out. The buccal glands have a common opening into the mouth, the loop-shaped gland ending in a narrow canal into which the ducts of the rounded glands open.

*Nervous System.*—An oval mass represents the brain and ventral ganglia; the posterior part shows signs of bilateral symmetry. A layer of small cells directly underlies the neurilemma. The twelve pairs of nerves are divided into two divisions, one directed forwards, the other backwards; but besides these there is an anterior, unpaired nerve, also found in *Rhyncolophus*, which overlies the œsophagus; the pair next behind this is the optic pair, and a pair lying beneath these probably supplies the palps; the next goes to the maxillæ; two stout pairs following these supply the two front pairs of legs. The two nerves of the fourth pair of legs are but branches of a single nerve.

*Generative Organs.* — Treviranus' account of these parts agrees much better than Pagenstecher's with the real state of the case. The ovaries are connected by a short bridge of tissue lying above the generative opening; the oviducts are directed forwards, and a circular arrangement of the organs round the opening, common in other Arachnida, is thus presented. The number of eggs in the ovary is innumerable, and they range from young elongated forms of ·05 mm. diam., with distinct germinal vesicle and spot, to mature individuals of ·15 mm., clouded by presence of yolk. The long and tortuous oviducts have their basal portions coiled up together; their median segments are thickened by a special external layer of cells, ·06 mm.

in diameter. The vagina has strong circular muscles, and is divided transversely by a constriction; the only accessory organs observed are three small globose vessels, situated on each side of the vagina, and consisting of a distinct membrane apparently with a cellular epithelium. Of the male organ the two testes form the chief part, and consist of plicated tubes with their walls, and contain several chambers lined with flat polygonal cells, enclosing a mass made up of small nucleated cells, apparently the sperm-cells. Two short, wide vasa deferentia, lined by circular muscles, underlie the testes. The medially placed ductus ejaculatorius, of similar structure, is about twice as broad, and terminates in a copulatory apparatus of the form of a bulb with a hollowed chitinous ridge, with two chitinous hoops at its sides, ending in a sharp, transparent, barbed point; the muscles are transversely arranged. The long, narrow accessory glands observed by Treviranus open into the distal end of the ductus ejaculatorius; they are difficult to disentangle from the surface of the testes, and are lined by an epithelium of roundish or cubical cells and by a fine membrana intima.

### δ. Crustacea.

**Central Nervous System of the Crayfish.*** — Herr Krieger appears to have a very high opinion of the usefulness of osmic acid, which he ordinarily applies thus: The ganglia having been removed from the crayfish, are placed on a slide over the mouth of a wide-necked flask containing the acid. After having been thus subjected to its vapour they are removed to picrocarmine, in which they remain for twelve hours; they are then macerated in very dilute picrocarmine, to which a little picric acid has been added. This treatment is best adapted for the demonstration of the nuclei, and the protoplasm of the ganglionic cells. After entering into the mode of investigation in further detail, the author passes to the descriptive portion of his paper; this falls under two heads: (1) Histological, and (2) Topographical.

(1) Commencing with an account of the ganglionic cells of the central nervous system, the author says that they are in all cases destitute of a membrane, are more or less spherical or pyriform in form, and provided with a proportionately large and spherical nucleus. The following forms may be distinguished:—

*a.* Cells with distinct protoplasm, and generally with a number of nucleoli within the nucleus.

*b.* Small cells with a delicate fringe of protoplasm, which is most distinct in the neighbourhood of the process given off from the cell.

*c.* Very small granular elements, with processes; the protoplasm is evanescent; the fine, granulated, cell-contents are highly refractive, but there are no evident nucleoli.

The fibrous elements may be divided into those which belong to the ganglionic processes, to the fibres of the transverse or of the longitudinal commissures, or to the peripheral nerve-fibres; histologically, they may be said to be tubular and well developed, or fibrillar and

* 'Zeitschr. wiss. Zool.,' xxxiii. (1880) p. 527.

delicate. The author finds no evidence that the former are compounds of the latter; and in this he is supported by Helmholtz, Haeckel, and Yung. Two of the fibres of the longitudinal commissures are especially distinguished by their size; these are the "colossal" nerve-fibres. Krieger has been led by his observations to regard the bundle of fine fibres which were first described by Remak as placed in these to be merely coagulation-products. When carefully prepared, the contents of the colossal fibres may be seen to be clear and homogeneous, but after a period of removal from the body delicate striations appear, and gradually become more distinct.

*Dotted Substance.*—Even with the naked eye, in the fresh condition, it is possible to see in the ganglia of the crayfish whitish spheres of a comparatively considerable size; when these are examined under the Microscope, they are seen to be neither ganglion-cells nor fibrous bundles, but rather to consist of a finely granulated mass; this dotted substance is by Krieger, as by Leydig, Dietl, and others, regarded as being a network of very delicate fibres. The true characters of the body may be demonstrated by two different methods. Of these, one is due to Dietl, and consists in making fine transverse sections of a ganglion which has been hardened in "osmium"; the other method is thus described: A portion of a ganglion is placed for several days in a 0·1 per cent. solution of chromate of ammonia, is then teased up with fine needles, and placed under a covering glass in the same fluid. After a brief description of the connective tissue, the author passes to (2) The Topographical relations of the Nervous System.

*Cerebrum.*—When we examine this in transverse sections, we first meet with the two optic nerves; here, two kinds of fibres can be easily distinguished, one of which is much more delicate than the other. The fine fibres appear to decussate completely, and not to form a semi-decussation, as has been stated by Dietl. In the anterior enlargements of the cerebrum there are some structures which are not easily comprehended; the first of these is a band of coarse dotted substance, which intervenes between the two pairs of spheroidal bodies which are placed near the chiasma, and the other consists of a pair of rounded bodies, which are made up of a fine dotted substance placed below the just-mentioned spheres.

Passing to the œsophageal commissures and their ganglia, the author points out that the former are made up of fibres, which arise from the dotted substance of the anterior and posterior swellings of the cerebrum. After giving a careful description of the ganglion and of the nerves which are given off from it, he passes to a consideration of the different parts of the ventral chain; he here enters into great detail, which it would be impossible to make clear without a reproduction of the figures by which they are illustrated.

**Influence of Acids and Alkalies on Crayfishes.*** — M. Richet commences by pointing out the impossibility of subjecting air-breathing animals to the influence of acids or alkalies. On the other hand, the

* 'Comptes Rendus,' xc. (1880) p. 1166.

crayfish affords an extremely easy subject, and the author has been enabled by its aid to convince himself that acids or alkalies are not poisonous because of their acidity or alkalinity. This is shown by the following facts: A crayfish can live for two or three hours in water containing 25 grammes per litre of acetic acid; if there are only 20 grammes per litre it can live for half a day. The mineral acids are the most fatal; in 5 grammes (per litre of water) of sulphuric acid, a crayfish dies in less than an hour; if the water only contains 1 gramme per litre it may live for ten to twelve hours. Nitric acid has still more marked effects; half a gramme in a litre of water will kill a crayfish in two or three hours, and if the quantity of acid be doubled, the creature will die in half an hour at the outside. The first tissue to be affected appears to be the muscular, and it is a long time before the effects are lost after the animal is removed from the acidulated water.

Alkaline solutions appear to have a more marked effect; the least hurtful is baryta, of which 3 grammes may be put into a litre of water for the crayfish to remain alive for two or three hours. The most fatal alkali is ammonia; half a gramme in a litre of water has an almost instantaneous effect, and even with one-tenth of a gramme the crayfish dies in two or three hours. It is, in fine, even more fatal than strychnine.

The differences in effect would appear to be due to the different degree in which the drugs are absorbed by the respiratory organs.

**Head of the Lobster.***—Professor Young shows some important relations in the grooves on the carapace. The so-called "cephalic groove" is really double: its anterior lateral branch starts from the antennary sternum, and marks off a prestomial segment. This distinction of a prestomial region is paralleled in the Annelids, where also it is supplied from the supra-œsophageal ganglion. In the Stomapoda and in the Pontellidæ the antennary segment is free. The posterior lateral branch begins rather posteriorly—behind the maxillipedes—and passes forward to join the former opposite the articulation of the mandible. From the posterior position of this latter groove, which marks the hinder limits of the strictly oral segments, it is seen that no place is left for the sterna of the maxillipedes' segments, and their terga are but small.

Claus's statement that the mandibles do not originate from the third pair of Nauplius limbs, but from the body-surface behind them, is borne out by the observation of such a development of it from the lateral oral margin behind and on the inner side of the third pair of appendages in some Macrurous larvæ; it is thus similar in origin to the labrum; probably the third larval pair of limbs fuses with it, constituting the mandibular palp, which is supplied from the supra-œsophageal ganglion, which also supplies all the prestomial region.

This prestomial region includes the eyes, antennæ, antennules, with the sense-sacs at their base; it is a primitive division of the body, and its relation to the nervous centres supports the view that

* 'Journ. Anat. et Physiol.' (Humphry), xiv. (1880) p. 318.

the supra-œsophageal ganglion is one of a tergal series of ganglia corresponding to the more fully developed sternal set, and so the region itself may consist simply of terga whose development has been affected by the disproportionate growth of the terga posterior to them, which constitute the carapace.

**Shortened Development in Palæmon potiuna.***—To the list of land and fresh-water animals which dispense with the development through which their marine allies pass, Dr. Fritz Müller adds the Brazilian *Trichodactylus* and *Æglea Odebrechtii* from the Decapod Crustacea. The fresh-water shrimps of the mouth of the Itajahy, however—a *Leander*, a *Palæmon*, and a species of the *Atyinæ*—leave the egg in the zoœa stage. On the other hand, the female of *Palæmon potiuna*, instead of laying the large number of eggs usual with kindred species under the same conditions, produces from six to twenty large ova, 2 mm. in length, from which issue young of 5 mm. length, having all the deportment of adults, whose form they assume fully at the fourth change of skin. The condition in which the young leave the egg is that of the larva of *Hippolyte polaris*, except that the gills are well developed while the mouth-parts are mere rudiments.

The changes through which the different organs pass with the four changes of skin are as follows:—

*Frontal process of the carapace*, from a short tooth- and hairless process to one with generally six to seven teeth, with corresponding tufts of hair in front of them on the upper edge and one or two on the lower edge, which bears a double row of hairs.

*Front edge of carapace* at first bears a single inferior bristle, and finally an antennal and hepatic bristle, a branchiostegal having appeared in the fourth stage, and having apparently fused with the hepatic in the last stage.

*Front antenna* at first zoœiform; protopodite unsegmented, a bristle on the inner branch, two such on the outer one; finally, each of the last segments (generally ten in the male) of the inner division of the outer branch bears two transverse series of two or three olfactory filaments each.

*Hind antenna*, from having only the outer branch segmented, has both segmented, and provided, the one with bristles, the other with numerous bristles and a spine; this condition is reached at the second stage.

*Mandible* becomes two-branched, toothed, with a palp, instead of consisting of a single simple cylinder.

*Maxillæ* do not alter, nor do the *anterior maxillipedes*, materially.

*Middle and posterior maxillipedes:* the inner branches from the beginning are long, strong, and devoid of swimming hairs, but carry terminal claws, serving as legs; the only change is that they become comparatively weaker.

*Chelate feet*, from a segmented but rounded, hairless, immobile form to chelate appendages with comb-like ornatory spines (the posterior pair becomes longer than the body in very old males).

* 'Zool. Anzeig.,' iii. (1880) p. 152.

*Ambulatory abdominal legs*, from being hairless and immobile, become fully developed at the first change of skin.

*Gills* fully developed from the first.

*Post-abdominal legs* begin by having all their ultimate structures, except the hairs and grasping hooks, of which the here specially long appendage of the endopodite of the second pair is the last to be added.

*Tail* has a distinct end-piece, with thirty-two to thirty-four bristles, mostly plumose on both sides: the lateral tail-pieces are visible in the interior. At the third stage the feet and outer and inner lateral laminæ appear; at the fourth the inner laminæ are longer and broader, and set round with plumose bristles; at the fifth and last the median piece becomes pointed, and carries two pairs of strong spines laterally. The number of its plumose hairs diminishes to eight or nine (subsequently raised to twenty and upwards).

The reason of the almost entire absence of the zoœa-structures in the newly-hatched young appears to be due to the, at times, turbulent streams inhabited by the species, which are liable to be flushed by torrents; hence the zoœa and all larval stages, in which a swimming mode of progression exposes them to injury from this cause, are passed through in three or four days, at the end of which time the ambulatory legs with their sharp and strong claws are well developed.

It is strange that the very closely allied *Hippolyte polaris* also has a shortened development, while a Brazilian *Hippolyte* is known to emerge from the egg as a zoœa.

**Toilet-appendages of the Crustacea.***—In the genus *Palæmon*, Dr. Fritz Müller states, the first pair of feet is used for the cleansing of the body and the respiratory chambers. Its structure adapts it admirably for this purpose: it is slender, often exceeding the body in length, and its pincers are small, but the grasping limb is articulated so as to be movable in almost any direction; at the proximal end of the chelæ are ranged several groups of short bent bristles with comb-like teeth on their inner aspects. The outside of each limb of the pincers carries several bundles of straight, stiff, roughened bristles, so that it resembles a brush; their inner side also carries a similar series of smaller bundles, pointing towards the apex, and so arranged as to interlock when the "fingers" are brought together.

In the working of these parts in life this pair of limbs is applied to all parts of the body, and especially to the respiratory chamber, and is there moved about so as to remove foreign particles. They are also used to convey to the mouth small pieces of carrion which they have torn off; the animal also, according to Hensen's observations, uses them to place grains of sand in the auditory cavity after each change of skin, as the mass of sandy otoliths is cast off with the skin.

In other Shrimps, as *Alpheus* and *Palæmon*, it is probably the second pair of feet which fulfils the cleansing function; they are very

* 'Kosmos,' iv. (1880) p. 118.

slender, carry small chelæ, and are rendered more mobile by the fact that the fore-arm is broken up into a number of small joints: the first pair of legs is strong, with powerful chelæ. In the hermit-crabs, the porcellanous crabs, and the Galatheidæ, on the other hand, it is the fifth pair which is thus used; they are thin, with very mobile joints, have small pincers well supplied with brushes, combs, &c.; they chiefly act on the gill-pouch. A commensal *Porcellana* living with an especially mucous worm, was observed to keep these limbs in constant motion over all parts of the body. In the crayfish, lobster, and prawn none of the pairs of feet appear adapted for this purpose.

In the Crabs, each of the six maxillipedes bears a long process, pointing backwards, the edges thickly set with long hairs; the whole has the outline of a sabre, and acts like a dusting-brush. The one belonging to the first pair lies outside the branchial cavity, the other within it, where they constantly play backwards and forwards between the branchiæ and the carapace. The hairs which clothe them show an immense variety in the form and arrangement of their teeth, of which *Trichodactylus*, *Gelasimus*, *Hepatus*, and *Lupea* afford interesting examples. In *Trichodactylus* the inner wall of the chamber, too, bears a number of small protuberances, each terminated by a spine; the function of the spines is to cleanse the hairs of the brushes above mentioned, as they pass to and fro. *Trichodactylus* is also remarkable, though not entirely peculiar, for leaving the egg as a fully developed crab.

**Anal Respiration of the Copepoda.***—Mr. M. M. Hartog, in a note on *Cyclops* read at the British Association,† pointed out that its respiration was exclusively anal. He has now made out the same in *Canthocamptus* (fam. Harpacticidæ), and *Diaptomus* (fam. Calanidæ). In all three the mechanism is the same; at regular intervals, after the backward sway of the intestine, the anal valves open for an instant and then close, giving just time for a slight indraught of water after the opening, a slight expulsion at the close. The necessary pressure to confine the animal seems to interfere somewhat with these movements, sometimes stopping them, if excessive; hence he "refrains from noting with illusory exactness the intervals between each respiratory movement."

It is to be noticed that the rectum contains as a rule liquid only, the bolus of fæces remaining in it but a short time. By endosmose the liquid in the rectum will tend to be at the same condition of gaseous saturation as the body-fluid around it, kept constantly agitated by the backwards and forwards sway of the stomach. During the short interval that the anus is open an approach to gaseous equilibrium with the external water takes place, even despite the very slight movement of the water (shown by the little change of place undergone by suspended indigo or carmine particles). In the absence of any other suitable respiratory apparatus, no one can hesitate as to the function of the action described.

In the *Nauplius* larvæ of *Cyclops* and *Diaptomus* the working is

* 'Quart. Journ. Micr. Sci.,' xx. (1880) p. 244. † *Ante*, p. 254.

slightly different. The rectum is a subspherical muscular sac, which at regular intervals contracts so as to leave a linear cavity (along the long axis of the animal), and immediately dilates, sucking up the water from without. An anal respiration, such as that of *Cyclops*, is found widely among Crustacea—even those which have well-developed gills like *Astacus*, which is one of the highest forms. It has been demonstrated in Phyllopoda and Cladocera, and is probably the exclusive mode in *Leptodora*, as shown by Weismann. That it is therefore primitive, and should be expected to occur in the primitive, or at least very generalized group of the Copepoda, is an obvious deduction. Hence the author anticipates that the homœomorphic zoœa larvæ of the Decapoda will prove to have this same mode of respiration.

If there be any connection between Rotifers and *Nauplius*, it is easy to make out the origin of the arrangement in the latter. The ciliated funnels and lateral canals of the former can only be of service when there is a thin unchitinized anterior surface through which water can transude into the cœlom; by the extension of chitinization over the whole surface, these organs lose their function and abort, while the cloacal "contractile vesicle" takes on an inspiratory as well as an expiratory function, and becomes more or less confounded with the rectum, from which probably, even in Rotifers, it takes origin.

Here must be noticed the wide diffusion of anal respiration in aquatic insect larvæ (alternate inspiration and expiration by the pumping movements of the rectum). This would point to a common origin with Crustacea.

A list of the groups in which anal respiration is made out may be added:—

VERMES:
- *Rotifera.*
- *Gephyrea.*
- *Oligochæto-Limicola.*

ECHINODERMATA:
- *Holothuroidea.*

ARTHROPODA:
- *Crustacea* (general).
- *Insecta* (most aquatic larvæ).

MOLLUSCA:
- *Dentalium.*

**Parasitic Corycæidæ.***—Dr. Della Valle makes some contributions to our knowledge of the anatomy of the genus *Lichomolgus*, some species of which are parasitic on Actiniæ, while others are found on Mollusca, Worms, or Tunicates. He describes as new *L. actiniæ*, *L. pteroidis* (on *Pteroides spinulosus*), and *L. chromodoridis*, of which the female is alone known. He forms a new genus, *Anthessus*, for some forms allied to *Lichomolgus*, the species of which, *A. Solecurti*, and *A. pleurobranchiæ* are distinguished by the characters of their mouth-organs.

**Parasite of the American Blue Pike.†**—Professor D. S. Kellicott describes a new species of *Argulus* found on the blue pike (*Stizostethium*

* 'Mitth. Zool. Stat. Neapel,' ii. (1880) p. 83.
† 'Am. Journ. Micr.,' v. (1880) p. 53. See 'Nature,' xxii. (1880) p. 114.

*salmoneum* Jord.). The fishermen of the Niagara river at Buffalo say that when the water becomes warm the fish gets too lazy to take food, that it then loses flesh, and through its inertness becomes infested with these lice. Having given this subject especial attention, Professor Kellicott is inclined to think the account of the fishermen is correct. The parasite occurs usually on the top of the head of the fish. When there are several they are, as a rule, huddled together, often in heaps, so that the knife may remove a number at once; it occurs also on the fins. None were found in the mouth-cavity. As many as twenty were taken from one lean fish.

When living specimens of the *Argulus* were placed in a tank with a small specimen of *Lepidosteus osseus* and some minnows, they shortly fixed on them, and the minnows soon died, apparently killed by the parasites. When first put in, the fish would pursue and catch them, but would eject them with a suddenness and a queer expression that was most amusing. In a few moments they were left unnoticed by the minnows. The gar recoiled in evident fear when one would be seen approaching. A large female once fastened on to the long nose of the gar, where it clung for several days, despite the vigorous efforts of the fish to dislodge it. Cold weather seemed to destroy them; the fishermen assert that after frosts the blue pike become fat, and then no lice are found on them.

The species is called *A. stizostethii*. The author believes—against the assertion of Leydig—that the abdominal lobes have a function of respiration above all other parts of the body, and he describes with a good deal of detail the appendages to the several legs.

**New Crustacea.**—Mr. G. M. Thomas describes * some Crustacea from Dunedin Harbour, New Zealand, the maximum depth of which is about 6 fathoms. They include one new genus and six new species:—*Mysis denticulata*, *Paratanais tenuis*, *Panoplœa* (n. gen.) *spinosa*, *P. debilis*, *Amphilochus squamosus*, and *Megamœra fasciculata*. The last five are figured.

Mr. T. W. Kirk describes † *Palinurus tumidus*, the common crawfish of the Sydney market, the total length of which, from tip of beak to end of telson, is 24 inches, with a much swollen carapace 21½ inches in circumference. Though so large and common, it does not appear to have been hitherto described. It is very near *P. Hugelii*, from the Indian Ocean, but distinguished by its much larger size, by the beak, supra-orbital and antennal spines being turned upwards, and by the telson being less triangular and rounded instead of scarped.

H. Rehberg has investigated ‡ a spring in the island of Heligoland. He found *Gammarus puteanus*, a Cyclops which has been assigned by Frić to *C. pulchellus* Koch, but which is a new species, a new Acarid, and a new *Pleuroxus*, *P. puteanus*, n. sp. The latter is distinguished by having the body contracted behind, and the cephalic rostrum of about the same length as the labial appendage, and the eye four times

* 'Ann. and Mag. Nat. Hist.,' vi. (1880) p. 1. † Ibid., p. 14.
‡ 'Zool. Anzeig.,' iii. (1880) p. 301.

the size of the accessory eye. Labial appendage comparatively large, distinctly notched so as to appear as if composed of two blunt lobes; hind edge of shell straight, lower edge clad thickly with fine bristles, and having a spine behind. Surface of shell smooth. Postabdomen broad, contracted at posterior third, beneath which occur eight double teeth. A short and a long spine at the base of the caudal hooks. Length, ·33 mm.; height, ·25 mm. Its nearest ally is *Pleuroxus trigonellus* O. F. Müller.

The *Cyclops*, *C. helgolandicus* n. sp., has the front antennæ of fourteen segments, and reaching to the end of the first body segment when laid back; the first and eighth segments agree in length, and the fourth and seventh, which also agree, are together equivalent to one of these. Second pair of antennæ of four segments, the first being the longest. Eye with four edges, red or red-brown. Last segment of outer branch of fourth pair of feet has two spines externally, a spine and bristles above, and three long bristles internally. Rudimentary foot consists of a broad basal joint with an external bristle, and a narrow terminal joint with a spine and a long bristle. The last abdominal segment is the shortest, hinder edge fringed with fine hairs; caudal furca four times as long as this, its latter bristle at the third fifth. The ovisacs contain twelve to twenty eggs, round, projecting from the body. Total length, 1·66 mm.; without furca, 1·36 mm.

It appears to be derived from *C. pulchellus* Koch, differing from it mainly in having three fewer antennal joints, in being smaller, in the shortening of the basal joint of the first segment of the rudimentary feet, and of the second outer bristle of the caudal furca; but the species are alike distinguished from all others by a fringe of fine hairs on the first quarter of the furca, and by the position of the lateral bristle of the same at the third fifth of its length, and some other points.

The well was closed in 1809, so that the species appear to have become thus modified in the intervening period of seventy-one years.

## Vermes.

**Genital Glands and Segmental Organs of the Polychæta.***— After a short review of the history of our knowledge of this subject, M. Cosmovici commences an account of his own investigations by a detailed description of the anatomy of *Arenicola piscatorum*. In dealing with the circulatory system, he points out (1) that the branches of the ventral vessel go to a gill; (2) that they meet with a segmental organ, or (3) that they meet with both gill and segmental organ.

In describing the segmental organs, he commences by directing attention, in the first place, to the structure which he calls the organ of Bojanus. Of these there are, in *Arenicola*, six pairs, which are placed on either side of the ganglionic chain, and in the cephalo-thoracic portion of the lateral chambers of the body. They are not found anteriorly to the third or posteriorly to the eighth segment of the body. Though very variable in form, it is possible to make out in

* 'Arch. Zool. exp. et gén.,' viii. (1880) p. 233.

them an external border, which is concave, and by which they are attached to the wall of the body, and a convex border which is free and directed towards the ganglionic cord. The anterior extremity is convex, and is always closed; though the posterior extremity appears to be glandular in character, it is not really so; the appearance is due merely to its great contractility, and it is at this end that the gland communicates with the exterior. This communication is effected by a circular pore, of some size, which is only difficult to see on account of the rich supply of muscles with which it is provided. In addition to this communication with the interior, the pouches also communicate with the "visceral chamber" by an orifice placed near their anterior extremity; the whole of the interior is provided with very long cilia, which work towards the exterior orifice. In structure, these organs may be regarded as being composed of a wall, and of an epithelium. The wall is formed of muscular fibres, and of connective tissue; the former are most abundant in the region of the posterior orifice. The epithelial layer is composed of spherical cells, filled with yellow granules; the most superficial are ciliated and deeply pigmented. The walls are highly vascular, but there is no indication whatever of any glandular structure. The author is of opinion that not only in structure, but also in function, these bodies are to be compared with the molluscan organ of Bojanus.

Turning next to the segmental organs, we find that we have an organ, the tissue of which is completely transparent, and which is largely supplied with blood-vessels; these bodies are connected with the organ of Bojanus, and open by a wide orifice into the body-cavity. By means of this orifice, the tubes are easily enabled to act as the efferent ducts for the generative products. Connected with the segmental organs, and like them arranged in six pairs, we find the ovaries or testes: these are racemose in form, and their products, which escape young, fall first of all into the body-cavity. The student of this subject will see that the results here given are very far from being in accordance with the views of Williams; the comparison which the author institutes between them can only be referred to, as it is impossible to give any abstract of his review.

**Development of the Spermatozoa of the Earthworm.***—Mr. Blomfield commences with a careful account of the position and appearance of the testes of the earthworm, which is of value, as the much more prominent seminal vesicles are often mistaken for them. He describes them as pure white, translucent bodies, irregularly quadrangular in form, and rarely more than $\frac{1}{10}$ inch in diameter. By the assistance of Mr. Bourne, the author is enabled to explain how it is that the seminal vesicles are ordinarily taken for testes. In order to demonstrate the truth of Hering's account of the arrangement of these parts, Mr. Bourne examined a series of earthworms, and was able to demonstrate that in full-grown forms, such as are ordinarily chosen for dissection, the vesicles are so fully developed that the true testes are completely hidden from view. In immature specimens, these

* 'Quart. Journ. Micr. Sci.,' xx. (1880) p. 79.

vesicles form six small outgrowths on the septa of the ninth-tenth, tenth–eleventh, and eleventh–twelfth segments, respectively; the anterior pair grow forward so as to project into the ninth ring, the second grow backward into the eleventh, and the third into the twelfth ring; "the ciliated rosettes" of the seminal ducts are found in the tenth and eleventh rings, and by these the developing sperm-cells of the testes pass into the seminal reservoirs or vesicles, which become gradually larger as sexual maturity approaches.

After an account of the minute structure of the seminal vesicles, the author passes to his more immediate subject.

*Development of the Spermatozoa.*—"If a portion of the contents of a seminal reservoir are examined in salt solution, a great many of the stages of the developing spermatozoon are exhibited in one field." In his account of this subject, the author makes use of some terms suggested to him by Professor Lankester; the *spermatospore* is a term applied to the "constituent cells of a testicle, derived from the primitive germ-epithelium"; these cells, by the division of their nuclei, give rise to "*spermatospheres*," or "*sperm-polyplasts.*" "Each constituent of a sperm-polyplast is a *spermatoblast*, and when the process of division is over each spermatoblast becomes a *spermatozoon.* It does not, however, happen that the whole spermatosphere is converted into spermatoblasts; there remains a passive portion, which in the earthworm occupies a central position; this is the "sperm-blastophore," or "blastophoral cell."

The author then enters into a careful account of the development of the bodies thus defined, which is illustrated by his own drawings, and comes to conclusions which are best stated in his own succinct résumé: The nucleus of the *spermatospore* in the young testis *is of unusually large relative size;* the second nuclei to which it gives rise stand out around the central mass (blastophore) of the generating spheroid with very little protoplasm clothing them. *The nucleus undoubtedly becomes the rod-like head of the earthworm's spermatozoon*, and the filament is as undeniably formed from non-nuclear protoplasm.

The sperm-blastophore of the earthworm is, however, non-nucleated, while in the frog and salamander the corresponding body is nucleated. This difference is, it is suggested, due to the fact that in the earthworm the spermatoblasts are further developed, not in testes, but in the seminal reservoirs, while in the vertebrates just mentioned a portion of the blastophore alone passes off, while the rest remains ready to resume its activity. In fact, what happens in the earthworm is the remarkable phenomenon of the primitive testis-cells passing into another organ in order to undergo their development.

**Embryology of Ligula.***—M. Moniez, in correcting and adding to the recent accounts of this phenomenon given by MM. Duchamp and Donnadieu, points out that before development commences the egg consists of a single egg-cell (which has been taken for a germinal vesicle); this lies in the midst of nutritive globules of various sizes,

* 'Bull. Sci. Dep. Nord,' iii. (1880) p. 112.

which generally conceal it. Segmentation takes place in the midst of the nutritive yolk, the egg-cell not issuing from it previously, as in *Tænia*. As it increases in size it drives the yolk-globules to the periphery, where they often present the appearance of polygonal cells. After segmentation the egg consists of finely granular cells, but slightly connected with each other; it undergoes delamination in the same way as in *Tænia;* the central part forms alone the six-spined embryo, the external part becoming clothed with cilia, and constituting the "embryophore," within which the embryo lives free. The latter and its capsule emerge from the egg on the disappearance of the egg-operculum, and rapidly (in one or two seconds) become far greater in size than the egg itself. This is owing to the absorption by the embryophore of a large quantity of liquid, converting it into a finely granular and very delicate reticulum. The cilia now rotate the whole; they are short and uniformly distributed; a slight pressure expels the embryo, which after abandoning the embryophore, creeps about by amœboid movement, showing its constituent cells plainly. It is therefore the embryophore—and not the embryo, as stated by M. Donnadieu—which moves as if it was ciliated, and the existence of the cilia upon it, pointed out by Leuckart and others, is beyond all doubt.

**Nervous System of the Trematoda.***—Dr. Lang's second communication on this subject commences with an account of the nervous system of the Tristomida. After reviewing the works of earlier writers, among whom Blanchard, Kölliker, and Taschenberg (1879) have been the most conspicuous, he proceeds to give an account of his own investigations on *Tristomum molæ*. The best subjects for investigation are the smaller specimens, on account of their greater transparency; the principal parts of the nervous system can be made out in the living examples, for the pale nerve-cords are composed of coarse fibres, just as in *Planocera Graffii* among the Dendrocœlous Turbellaria.

The flattened body of these creatures has its periphery almost round; at the anterior end of the ventral surface there are two oral suckers, and in their neighbourhood the margin of the body is so indented as to give the appearance of a quadrangular median lobe. The abdominal sucker is very large and powerful, and is connected by a short thin stalk with the body. On either side of, and not far from the pharynx, there are two vesicles belonging to the water-vascular system. The cerebrum lies anteriorly and superiorly to the pharynx and mouth; in form it is a short, pretty broad transverse band, with a concave posterior edge. There are connected with it four small pigment spots. On each side of the cerebral mass there are given off four nerves, which are thus distributed. The most anterior pass to the region between the oral suckers, where they branch and anastomose. The succeeding nerves supply the oral suckers themselves, and have connected with them the third pair of nerves, part of which cross over, however, to the opposite side of the body. Where they unite in the middle line, an unpaired nerve passes forwards to the cephalic lobe.

* 'Mitth. Zool. Stat. Neapel,' ii. (1880) p. 28.

The arrangement thus brought about is not unlike that which obtains in *P. Graffii*, where all the nerves given off from the brain are connected together by a circular commissure; but in *Tristomum* there is not any direct continuation between the commissures in the posterior region. The fourth pair of nerves passes furthest backwards; and these may be seen to consist essentially of a feebly developed dorsal, and of two well-developed ventral nerves on either side. Of the ventral trunks, one is peripheral and external, the other internal; these again unite in the region of the great ventral sucker.

After describing in detail the distribution of these nerves, the author passes to the consideration of the minute structure of the nervous system; the examination of which is greatly aided by the large size of the ganglion-cells and of the nerve-elements, as well as by the distinctness of the nerve-tracts. A good transverse section of a ventral longitudinal nerve exhibits *par excellence* the spongy character of these fibres; of these there is a network, and in the midst of them there are a number of lumina of various sizes; these all contain some coagulated protoplasm, and in the larger ones nucleated cells are also to be distinguished. Careful examination of a number of sections reveals the existence of a number of tubes (*neurilemma*), and of nerve-fibres enclosed in these tubes. It would seem that, during life, the fibre completely fills the tube. It is concluded that, histologically at any rate, the cerebrum is nothing but a specially and highly developed transverse commissure, which indicates its relation to the central nervous system by being composed largely of ganglion-cells.

The eyes, which are extremely simple, consist of (1) an aggregation of pigment covering in (2) a spherical or oval refracting body, which in the anterior eyes is directed backwards, and in the posterior forwards. Connected with this there is (3) a typical ganglionic cell which forms the *retina*. (4) A spherical bundle of the dorso-ventral muscles appears to act as muscles for the eye.

Small peripheral nerve-centres appear to be represented by large cells which, scattered through the body, are best developed in the neighbourhood of those regions in which the musculature is best developed.

*Pleurocotyle scombri.*—The nervous system of this creature is the next subject of Dr. Lang's investigations. No eyes are here developed; the cerebral mass is delicate, and is made up of finer fibres; the most distinct nerves belong to four series:—

(1) A pair which pass forwards to the suckers.

(2) A pair which pass upwards—dorsal nerves—but which could not be traced for any great distance.

(3) A pair, which pass outwards and upwards, and are soon lost; and (4) A pair, better developed, of longitudinal trunks, which take a backward course along the ventral surface.

*Distomida.*—The examples of this group which were examined were *Distomum nigroflavum*, and *D. hepaticum*. The central nervous system of the former has the typical position, between the oral sucker and the pharynx. From its upper portion there is given off dorsally on either side a nerve for the oral sucker, and a nerve which passes backward; from the lower surface a delicate nerve goes to the ventral surface of the oral sucker, while there are also two ventral longitudinal nerves which, soon after their origin, give off a branch which takes a dorsal direction. Very similar arrangements are to be found in *D. hepaticum*, the results of his observations on which, by means of sections, the author carefully describes.

In conclusion, the author states that, with regard to the large cells, principally found in the suckers of these creatures, he is not able to affirm that they have any connection with the nerve-fibres which are distributed to the same parts. But he is of opinion that they are homologous with the cells of similar character in *Tristomum*, and he thinks that they should be regarded as ganglionic cells.

**New Turbellarian.***—Dr. Arnold Lang describes a new parasitic Rhabdocœle Turbellarian, but without giving it any name; it seems, however, to be closely allied to *Graffilla muricicola;* it is found in numbers on the foot of *Tethys*, but hardly appears to reside there permanently. Spindle-shaped when extended, and whitish in colour, they are almost completely dense; little even can be made out when they are compressed. The epithelium of the integument is ciliated, and the cells are polygonal; no sagittocysts are developed, but here and there there are pores for the tegumentary glands; below the integument there is a rudimentary muscular layer, which is so feebly developed that it can only be detected in very thin sections; in this region there are a large number of unicellular pyriform glands, which are specially developed in the anterior region of the ventral surface. The pharynx, and its musculature, are very feebly developed, and the former appears to be devoid of a sheath. The intestine, which is aproctous, forms the greater part of the animal; its lumen varies in width owing to the development of inwardly projecting processes, and its walls are formed by very long tubular cells, distinctly separated from one another, and, as it seems, inserted directly into the integument. No peripheral nerves, special sensory organs, or water-vessels were detected. The female organs were well developed, but in no specimen was the author able to find the male glands in anything but a rudimentary condition.

**New Nemerteans.**†—Dr. Hubrecht, in a first appendix to a paper already noticed,‡ points out that among the Palæonemertini we may either find the system of respiratory furrows represented by a number of small grooves (*Polia*), or there may be only a simple transverse furrow (*Cephalotrix*), or no furrow at all. He then describes a new species, *Carinella inexpectata*, which seems to be intermediate between the two forms with simple or compound grooves; for here we have to do with a transverse groove, provided with a set of small secondary grooves, very much as in *Polia;* from which, however, it differs, and agrees with the simpler forms in having no third pair of lobes to its cephalic ganglion. The other new species described belongs to the genus *Cerebratulus*, and is dedicated to Dr. Eisig, of

* 'Mitth. Zool. Stat. Neapel,' ii. (1880) p. 107.
† 'Notes R. Zool. Mus. Netherlands,' ii. (1880) p. 93. ‡ *Ante*, p. 438.

Naples, to whom the author owes so much. The specimen on which the description was founded was sent to him alive from Naples; it is distinguished by the presence of longitudinal stripes on its proboscis, and by its dark olive-green colour.

### Echinodermata.

**New Genus of Echinoidea.***—Under the name of *Palæolampas*, Professor Jeffrey Bell describes an irregular Echinoid allied to *Conoclypeus* and *Echinolampas*, but distinguished from them by the possession of certain more archaic characters; the pores of the ambulacral areæ are arranged in pairs as far as the ambitus of the test, while the outer row of each pair extends regularly to the actinostome. The pores of each pair are not yet connected with one another by grooves; those of the inner rows are still fairly circular, but many of those in the outer rows are slit-like or comma-shaped, and indicate the commencement of the formation of the groove connecting the pairs of pores. Two of the ocular plates are interesting on account of their still retaining indications of their primitively double nature. The whole test is regularly covered with primary tubercles, and there are no bare bands even near the mouth, at which, also, the bourrelets are but feebly developed. The generalized, or feebly differentiated, characters of the form are curiously enough spoken to by the fact that nearly all naturalists who examined it hastily thought that they had seen it before; one, however, thought he had a specimen belonging at any rate to the same genus; it was only some time after the reading of his paper that Professor Bell was enabled to see the specimen in question; of this he has since given a short account to the Zoological Society, and we are enabled to say that he finds himself compelled to regard it as an immature specimen of the more highly specialized genus, *Echinolampas*. If this be the correct view, it affords another example of the resemblance of the young forms of differentiated species to the adult forms of less differentiated creatures, and aids in compelling us to accept the aphorism: "The development of the individual is a compressed epitome of the history of the race."

**Fossil Tertiary Echini.**†—Dr. Martin has arrived at the very interesting conclusion that a considerable percentage of these fossil Echinids, from Java, are still represented in the Indian Ocean; the tertiary species were described by Herklots as new, and these determinations the present writer now revises. The author gives a valuable table of the species found, and shows what are still living, and what are their allies, either extant or fossil. He arrives at the important result that even in the tertiary period the tropical oceanic fauna appears to have been quite as distinct as it is in the present day, for they contain no fossils which have yet been found in extra-tropical tertiary deposits. This, as a second table shows, is indicated also by other groups of the Invertebrata; but in none perhaps is it

* 'Proc. Zool. Soc.,' 1880, p. 43.
† 'Notes R. Mus. Netherlands,' ii. (1880) p. 73.

more evident than with the Echinoidea, 57 per cent. of which are identical in the present time and in tertiary deposits; the Crustacea, indeed, give a percentage of 67, but we know of only 9 fossil species of this order, whereas 19 Echinoidea have been discovered. 6 Foraminifera, 1 Cephalopod, and 1 Brachiopod have been found fossil, and none of these are identical with recent forms.

**Remarkable Ophiurid.***—Herr v. Martens gives a description of a new species, *Ophiothela dividua*, from Algoa Bay. The species was six-rayed, but was remarkable for the fact that in the large number of specimens examined, the arms of each individual were always unequal in size, and that the longer arms all lay on one side of the disk; there might be three large and three small, or two large and four small arms. It would appear, therefore, that the creature had undergone transverse division, and that the smaller arms were newly formed. These specimens afford some support to the doctrine on which the author has previously insisted: that when star-fishes have more than five arms, it is, as a rule, in consequence of the animal having budded them off after division or injury.

**Mediterranean Echinoderms.†**—In the present essay, Dr. Hubert Ludwig gives a brief account of *Antedon phalangium*, and points out the differences between it and *A. rosacea;* and of *Astropecten squamatus*, of which he has been enabled to examine Müller and Troschel's type-specimen, and with which he associates Philippi's *A. aster*. He then describes a new species of the Ophiurida, *Ophioconis brevispina*, of which genus as yet only two species were known. In giving an account of *Thyone aurantiaca* he points out that the presence of a male genital papilla appears to be very common among the Dendrochirotæ; and he concludes with a notice of a Mediterranean species, *Holothuria mammata*, which was described by Grube in 1840, and appears to have been never again observed.

### Cœlenterata.

**Intracellular Digestion in Cœlenterata.‡**—Professor Metschnikoff considers that this phenomenon, already demonstrated by Jeffrey Parker in *Hydra*, must be regarded as the rule in most of the true Cœlenterates. It has now been observed in the Hydroids *Plumularia*, *Tubularia*, the Hydromedusæ *Eucope*, *Oceania*, *Tiara*, as the intrusion into the endoderm cells of solid alimentary particles; also in *Pelagia*, *Praya*, *Forskalia*, *Hippopodius*, in the Ctenophoran *Beroë*, and in the Actinians *Sagartia* and *Aiptasia;* it has not been noticed in the Trachymedusæ. In the Hydroidea and Oceanidæ almost the whole endoderm has this property (in *Eucope* the genital organs, the wall of the circular vessel, and the base of the tentacles were thus penetrated), but it is usually limited to certain cylindrical thickenings; in the Siphonophora it is exerted only by the thickenings of the median division of the stomach; in *Actiniæ* the mesenteric filaments must now be

* 'SB. Ges. Naturf. Freund. Berlin,' 1879, p. 127.
† 'Mitth. Zool. Stat. Neapel,' ii. (1880) p. 53.
‡ 'Zool. Anzeig.,' iii. (1880) p. 261

regarded as digestive organs owing to the same occurrence in their ordinary entoderm cells, thus explaining Lewes and Krukenberg's observations of the complete absence of any free digestive secretion; on the other hand, the Hertwigs' interpretation of the abundant gland-cells which abound here, must be rejected, and they must be regarded instead as mucus-glands. The Cœlenterate entoderm cells are ranked among the amœboid epithelia, taking in as they do, their food by pseudopodia-like processes; this is well seen in *Praya diphyes*, whose cells are long and envelope food-particles in a *plasmodium*, formed of the fused pseudopodia; a similar fusion of the ends of the cells occurs in the Ctenophora and *Actiniæ*. In Ctenophora the food-particles pass into the wandering cells of the mesoderm, as in sponges.

Considering that representatives of all the chief groups exhibit this phenomenon, it would appear to be a primitive endowment of the Cœlenterate type, and—the same being the case with the lowest worms, the Turbellarians—also of the Metazoa in primitive times. As the method does not demand a special digestive cavity, this last would appear, where present, to be of secondary origin.

Probably some points in the development of Cœlenterata, which as yet appear at variance with the gastræa-theory, may be explained by these considerations.

**Nervous System of Beroë.***—Dr. Eimer recapitulates the present condition of our knowledge of the nervous arrangements in the Cœlenterata. He points out that in an earlier work he had insisted on the fact that the nervous system of *Beroë ovatus* was not distinctly localized, but was represented by a number of nerve-cells which were distributed over the whole surface of the body, and were numerous only in the region of the anal pole; no true nerve-cords, such as are seen in the higher animals, are to be found in this Ctenophore. Very similar results have been shown among the Medusæ; here there is a lamellar central nervous system distributed over the body, and attaining its greatest development in the Craspedota in the region of the margin of the umbrella (Cycloneura), and in the Acraspedota in the region of the marginal bodies (Toponeura). In both these groups the nervous elements may be frequently connected with the epithelium. In these, just as much as in *Beroë*, it is difficult to distinguish the nerve-cells as morphological elements, but this is, of course, in complete agreement with the *à priori* consideration that characteristic tissues are no more suddenly developed than are distinct functions. Physiological experiments on the Medusæ have confirmed these views: it now remains to apply the same test to *Beroë*.

Experiment A.—Specimens were so operated on as to divide them into three equal parts, representing respectively the anal pole, the oral pole, and the median portion of the body; when this was done it was found that all the ctenophores ceased their activity; after a short time, however, this again reappeared in the parts connected with the anal pole; after four hours nearly all the parts were in

* 'Arch. Mikr. Anat.,' xvii. (1879) p. 213.

movement. On this, small pieces were cut off from different parts of the body; at first without movement, in two hours after they were quite active. In the second area, exhibitions of movement were very common. In the third, all the parts and pieces were quite active. In the median portion the ctenophores of one row exhibited a contrary direction to the rest. These experiments conclusively demonstrate that parts disconnected from the anal area are capable of independent movement.

Experiment B.—A row of ctenophoral plates was separated by incision, and a division transverse to its long axis at a distance of about 2 centimetres from the anal pole was made; for a moment the movements of all the ctenophores ceased; then the uninjured plates began to move, then the distal portion, and last of all the proximal (oral) portion of the injured plate exhibited activity. In the last two the movements were independent of one another. These experiments throw into marked relief the extraordinary capacity which the different parts of the injured *Beroë* have of performing separate movements, just as though they were distinct animals.

The author further found that the movement of the injured animals was in the same direction as that of the uninjured, and that the same power of direction was possessed by them after and before the experiment.

Looked at generally, these remarkable observations afford conclusive support to the doctrine that the "central region" at the apical pole is not really the centre of the nervous energy of the animal, while they show that nerve-cells are at any rate scattered over the whole of the body, however more numerous they may be in one region, and, moreover, these nerve-cells may be functional centres for any given part of the body. The facts here detailed are completely paralleled by the results already obtained from the study of the Medusæ, and we may safely assert that "a distinctly localized central nervous system is not present in *Beroë*; its central cells are distributed over the whole body and are only more closely aggregated in the region of the anal pole."

**Pleurobrachia pileus.***—In a few notes on this animal, no specimen of which was found in a sexually mature condition, Herr Hartmann points out the presence on two lobes of two round, red, granular pigment-spots; these, which it is possible were rudimentary eyes, are not to be confounded with the ctenocyst, or auditory vesicle. The œsophagus-like portion of the digestive canal was connected with the stomach and the funnel by an orifice surrounded by a circular projection, and provided with circular and longitudinal muscles. At the oral pole he detected ganglia which gave off nerve-filaments to the ctenophoral plates, and to the parenchyma of the body, and which were further connected with one another by transverse commissures. The branches of the tentacles were beset with a number of rounded tubercles, between which there was diffused, in the primary portions of the tentacle, a reddish pigment; these tubercles were provided with a number of urticating capsules.

* 'SB. Ges. naturf. Freund. Berlin,' 1879, p. 25.

**Anatomy and Histology of the Actiniæ.***—In continuation of our account of the paper of the brothers Hertwig,† we direct attention to their history of *Cerianthus*, *Edwardsia*, and *Zoanthus*, which is not so elaborate as the preceding portion.

With regard to *Cerianthus*, the most important observations are those which deal with the layer of muscles subjacent to the nervous system. Forming but a thin layer in the tentacles, they form a more considerable stratum in the oral disk, and here each muscular band has, as a supporting lamella, a thin homogeneous layer, which presents a free edge towards the nervous layer, and is, as compared with the same part in the *Actiniæ*, much better developed. In the tentacles the elements of the muscular layer are isolated. The middle layer of the body is distinguished by the simplicity of its characters, and the complete absence of special connective-tissue cells. The endoderm, also, presents points of difference, for its cells are not, as in the *Actiniæ*, provided with a single flagellum, but with a tuft of delicate cilia. Parasitic cells are here completely absent. The œsophagus is, as compared with that of the *Actiniæ*, extremely short; there is only one œsophageal groove, and we are therefore enabled to distinguish a ventral and a dorsal aspect; when, however, we inquire which is the dorsal and which is the ventral, we find that our authors are in opposition to Haacke,‡ and that they regard the side on which the groove is developed as being the ventral one. In the walls of this œsophagus there is developed a special muscular lamella. The septa of *Cerianthus* are only feebly differentiated from one another, and this simplicity in character extends even to their histological details. After pointing out the leading characters by which they are here distinguished from the *Actiniæ*, the writers proceed to an account of the generative organs; these are very numerous, as they are developed on every septum, at the point at which that process ceases to be invested by the œsophagus; both ova and spermatozoa may be found to be enclosed in a capsule of connective tissue, and the testicular follicles are not only set between each of the ovarian but are also found to be aggregated into special bands.

The most interesting characters in *Edwardsia* affect the important question of the *morphology of the septa;* in these creatures there are, as Quatrefages showed, only eight septa; these are all inserted into the œsophagus, and they are all extremely muscular; they are arranged in an exactly symmetrical relation to the two œsophageal grooves. Contrary to what obtains in all allied forms, the tentacles are not numerically similar to the septa; in other words there are more than eight, and the number present is not even always a multiple of that number.

Passing from these details to a general part, the authors commence with a chapter on the classification of the Cœlenterata; to make this complete they are compelled, after dealing with the systematic relations of the forms already described, to enter upon the relations of these to the other Anthozoa, and to an account of the generative

* 'Jen. Zeitschr. Naturwiss.,' xiii. (1880) p. 565. † *Ante*, pp. 451–457.
‡ See this Journal, ii. (1879) p. 892.

organs of the Charabydcida, Discophora, and Calycozoa; into these details we cannot enter, but we give a brief résumé of their general conclusions. Putting aside the very distinct group of sponges, it is possible to divide the rest of the Cœlenterata into two great groups; (1) Ectocarpa, (2) Entocarpa; in the latter are all the Anthozoa and Acraspedota (with also the Charabydcida and Lucernarida), and in the other the Hydromedusæ (including the Siphonophora) and the Ctenophora. The most important difference between these two groups lies in the fact that in the former the generative organs are derived from the ectoderm, and in the latter from the endoderm; in one, therefore, the organs are exposed, and in the latter they are placed in processes of the gastro-vascular system. Other minor differences remain to be noted; in all the Entocarpa the matured generative products lie separately in the mesoderm; in the Anthozoa they are invested by fibrous connective tissue, and in the Acraspeda by gelatinous capsules. This is not the case with the Ectocarpa. Nor, again, is the mode of emission similar in the two divisions; in the Entocarpa the products pass into the gastro-vascular system, while in the Ectocarpa, with the possible exception of the Ctenophora, they pass directly into the water. The two groups may be thus conveniently and succinctly defined:—

The Entocarpa are Cœlenterata, in which the generative cells are developed in the endoderm, and pass when mature into the mesoderm; they are provided with a special secreting apparatus (the mesenterial filaments).

The Ectocarpa are Cœlenterata, in which the generative cells are developed in the ectoderm, where they remain; they do not possess any mesenterial filaments.

Other differences may be noted between these groups, but passing to their common origin, it may be noted that the original ancestor was doubtless very similar to *Hydra*, though somewhat more generalized in character, and with a much less marked differentiation of ectoderm and endoderm. The generative products had no defined seat of origin; when this began to obtain two distinct phyla were initiated; one led by the Hydroid Polyps to the Ctenophora, the other to the Scyphistoma-creatures, in which the generative organs had an endodermal origin, and in which the gastric cavity was interrupted by four longitudinal septa; this division broke up into the Anthozoa and the Acraspeda.

Some few points as to the histological details of the *Actiniæ* remain to be summed up:—

(1) The organs are chiefly developed from the ectoderm.

(2) There is a striking similarity between the histological elements of the ectoderm and endoderm.

(3) The neuro-muscular system is made up of three sets of cells, muscular, sensory, and ganglionic, and these are connected into one system by nerve-fibrils.

(4) The muscular fibres seem to have been primitively arranged in lamellæ. They grew inwards, and became separated into bundles by the investing connective tissue.

(5) Where no special optic organs are developed, some, at any

rate, of the sensory cells of the ectoderm must be sensitive to luminous impressions.

In conclusion, attention is directed to the bearing of the facts detailed on the germ-layer theory. The authors give a sketch of the change in thought which has had for its effect to give a general meaning to the words ectoderm, endoderm, and mesoderm; but this change has hardly been completely accurate. Let us take as an example the term mesoderm. The students of the embryology of the higher animals apply the word to a layer of embryonic cells; and they show that these cells become converted into definite tissues and organs. On the other hand, in the Cœlenterata, the word is applied to a definite layer of tissue, which is developed between the inner and outer epithelial layers. The matter may be best put thus: In the lowest divisions of the Metazoa there are only two layers, the *ectoblast* and *endoblast;* in the higher there is a third embryonic layer, the *mesoblast.* These three terms should be confined to the layers of the embryo, and should only be regarded as exhibiting topographical relations. The terms endoderm, &c., should be thus used: By endoderm and ectoderm we mean the outer and inner layers of the developed body, which have been developed from the ectoblast and endoblast of the germ, and have retained their primitive position; the term mesoderm is applied to the sum of all the tissues and organs which are interpolated between the bounding layers, and these may be either derivates of a special mesoblast, or have taken their origin directly from one of the two primary germ-layers. With these definitions we can formulate the two following laws:—

(1) As an animal increases in complexity of organization the size and complexity of the mesoderm increase, while the ectoderm and endoderm become more simple. In the Cœlenterata the ectoderm and endoderm fulfil the most varied functions of the animal, but in the rest these functions are taken on by the mesoderm.

(2) All the organs which in the higher orders are mesodermal, belong in the lower animals (with the exception of the vascular system, &c.—direct derivates of the mesoderm) to the two primitive cell-layers.

The facts detailed in this paper would, even if unsupported by other similar facts, be sufficient to demonstrate that, when we examine the question of the homology of the layers within the different divisions of the animal kingdom, we find that the germ-layers undergo different kinds of differentiation. This does not affect the general homology of the layers; how does it bear on the question whether the two layers have always the same relations to the tissues derived from them? After a review of a number of the facts which bear on the question, the authors come to the conclusion that the germ-layers are neither organological nor histological unities. We cannot argue from what we know of the development of an organ in one phylum as to its history in another.* The stem-form—the gastræa—must not be regarded as organologically and histologically indifferent; its descendants may have had their tissues and organs

* Compare with this M. Fol's views, *ante*, p. 605.

differentiated in various ways; just as individual cells vary in their characters, so too may the germ-layers give rise in various ways to the tissues and organs. The work now to be done is to define for each class of animals (1) how the primary layers of ectoblast and endoblast are converted into the definite layers and organs; and (2) how the cells are histologically differentiated in the separate layers.

**Structure of some Coralliaria.*** — Among the Coralliaria the *Actiniæ* have been the best studied. The almost total deficiency of facts concerning the microscopical structure of the other groups decided M. C. Merejkowsky to undertake a special study of some species common in the Bay of Naples. The following are his results.

The *ectoderm* is shown to consist of the following elements:—1. Ordinary ectodermic cells of very elongated form, excessively depressed and dilated at the upper extremity which is invariably furnished with only a single cilium. 2. Cells like the last but transformed at their base into an excessively long and slender filament, sometimes provided with several inflations which may be called the *nervous filaments*. 3. Epithelio-muscular elements composed of cells like the first (but shorter and broader), united at their base to muscular fibrillæ. 4. Nematocysts of two kinds, the larger ones often surrounded by protoplasm with a nucleus and a long filament (nervous) in the posterior part, the smaller ones of a different form and always furnished with a long posterior filament; the filament bears at places small knots. 5. Glandular cells always pyriform and with coarsely granular contents.

The *mesoderm* is an elastic and structureless membrane, varying in thickness in the different parts of the body. It forms longitudinal protuberances upon the faces of two mesembryenthal septa which unite at the surface of the stomach. The muscles which spread in a single layer over it are longitudinal in the interior of the animal and disposed in horizontal rings on the exterior. They are either long, slightly flattened filaments, the relations of which to the other histological elements it is not easy to ascertain, or they are fibrillæ forming a part of the epithelio-muscular elements.

Another very curious element consists of cells of comparatively large size, and excessively flattened, which ramify greatly and unite with each other by their ramifications, and are filled with granular contents, with nucleus and nucleolus. They are arranged in a layer and rest immediately upon the outer surface of the elastic membrane. From their form, habit, and position, the author has no doubt but that they are nervous ganglia in which the numerous fibrillæ of the different ectodermic cells terminate.

The *entoderm* is composed almost exclusively of very typical epithelio-muscular cells. The epithelial cell is not so strongly elongated as in the ectoderm, but with the base much dilated, and with a single cilium at the extremity. The muscular fibril is very

* 'Comptes Rendus,' xc. (1880) p. 1086.

refractive, fusiform, and nearly three times as long as the cell itself. Glandular cells not essentially differing from those above described are also met with.

*Mesembryenthal Filaments.*—The surface of the stomach is not smooth, but covered with longitudinal elevations, very rich in glandular cells, each of which corresponds to the place where a septum unites with the stomach. At the extremity of the stomach the protuberances form the free edges of the mesembryenthal septa; there is therefore an unbroken continuity of these longitudinal protuberances at the surface of the stomach with the mesembryenthal filaments, and this fact explains the complete unity in the structure of these two organs and shows that they can only act as an organ of digestion. The filaments are solid, and have no interior cavity. There is no canal passing through the septa and uniting the chambers formed by them.

**Antipatharia of the 'Blake' Expedition.***—Twelve species of this interesting group taken in the Caribbean Sea (1878–79) are described by L. F. Pourtalès. In determining the species an attempt has been made to use the differences in the shape of the polyps, as well as the disposition and form of the spines, to draw characters for a much-needed revision of their classification. It would seem as if there were at least two different types of spines; the triangular compressed and the more cylindrical. These latter are generally more densely set, even assuming sometimes a brush-like appearance, as in *Antipathes humilis*, a new and wonderfully spinous species, figured but not described. These cylindrical spines are also unequal on the two sides of the pinnules, being longer on the side occupied by the polyps, with a few very much longer around the polyps. In one species, however, *A. Desbonni*, the spines are in regular verticils. There would appear to be a connection between the shape of the polyps and the shape and disposition of the spines. Those species with triangular spines have polyps with longer tentacles than those with cylindrical spines, and the tentacles have a greater tendency to become regular in shape. In many species the tentacles are simply contracted; in a very few they were found retracted, as figured by Lacaze-Duthiers; and in some they are probably not retractile at all.

Eight out of the twelve named are either described or figured as new species. *A. spiralis* is a very interesting species, formerly referred to *A. Desbonni* D. and M. The polyps are alternately large and small, with very large digitiform tentacles much longer than have been figured of any *Antipathes* before. In the spaces between successive polyps the cœnosarc shows transverse canals, and those on the back part of the branch are more transparent than the rest.

**American Siphonophora.**†—Mr. J. W. Fewkes gives a sketch of the development of the tentacular knob of *Physophora hydrostatica*. The growth of this knob is here more complicated than in any

* 'Bull. Mus. Comp. Zool. Camb.,' vi. (1880) p. 95. See 'Nature,' xxii. (1880) p. 113.

† Ibid., p. 127. See 'Nature,' xxii. (1880) p. 113.

other Siphonophore; commencing as a bud on the ciliated base of the feeding polyp, it is at first only composed of an ectoderm and endoderm. The ectodermic wall divides into two layers and gives rise to the involucrum; within this the sacculus becomes coiled up, and shortly appears as a complicated organ armed with lasso-cells; meanwhile the basal portion becomes so enlarged as to give an asymmetrical form to the whole knob. As the fully grown stage is reached, this enlargement forms a simple tube along the side of the knob, and the complete condition is arrived at. It is interesting to note that in some allied genera we find arrangements of the parts of the knob which are only temporary in the species under description.

The mantle-tubes of *Apolemia uvaria* and *Gleba hippopus* are also described, and the tubes in the larger necto-calyx of *Abyla pentagona;* he adds some critical remarks on the genera *Halistemma*, *Agalma*, and *Agalmopsis*, and concludes with a notice of the forms of Siphonophora and Velellidæ to be met with on the eastern coast of the United States.

Up to the present few forms of either of these groups have been described from American waters. They seem to be only occasional visitors blown into the neighbourhood from mid-ocean, and brought there from the tropics by the Gulf Stream. The wealth of such species that one meets with in the Mediterranean is unknown on the New England coast; while, as the author says, in one day at Nice he has taken eight different genera of Siphonophora, yet at Newport he has but rarely taken as many as two genera in the length of a summer's day, and a whole summer once passed, during most of which he was almost daily on the water without one species being seen. One or two species of *Physalia* are, however, more common on the United States coasts than in the Mediterranean.

The only member of the long-stemmed Siphonophora provided with a float or air-bladder found heretofore on the New England waters is *Agalmopsis cara*. Mr. Fewkes can now add *A. elegans*, and he thinks that extended observation in the southern bays of the country will bring to light some of the well-known forms common to all oceans, such as *Apolemia*, *Abyla*, *Physophora*, and *Gleba*. Some of these have already been taken in the Gulf of Mexico and the Caribbean Sea. *Rhizophysa*, found in the same localities, might also be expected to be brought to Eastern American coasts by oceanic currents.

**Origin and Development of the Ovum in Eucope before Fecundation.***—This subject has been studied by C. Merejkowsky, who gives the following as the results of his researches. The ovaries of the Medusa, in the interior of the bell, have the appearance of four small sacs, due to an evagination of the gastro-vascular cavity. In the walls of the ovaries, from without inwards we find a layer of ectodermic cells, the limits of which are not well defined, and the entoderm composed of several layers of better defined cells. The innermost layer of the entoderm, that which covers the inner surface

* 'Comptes Rendus,' xc. (1880) p. 1012.

of the ovary, is composed of the same cells (furnished with a vibratile cilium) as the entoderm of the radial canals.

Towards the base of the ovary, where it becomes confounded with the lower surface of the bell, the entodermic layer is as yet only formed of a single stratum, as in the radial canal; but in proportion as we advance towards the interior of the ovary we see the entodermic cells divide in a direction perpendicular to their length, and thus form two superposed layers of entoderm; the division of the cells continuing in all directions, we thus find the entoderm grow thicker and thicker.

Between these two lamellæ of entoderm and ectoderm forming the ovary, is a third more delicate, structureless lamella—*the intermediate lamella*—sharply separating them and assisting us to define with certainty which layer produces the ova. These ova are always found *under* the intermediate lamella, and being thus separated from the ectoderm by that lamella can only be developed from the entoderm. This is further borne out by observing directly all the graduated transitions between the ordinary entodermic cells of the young ova. The changes in an entodermic cell destined to be developed into an ovum consist in the increase of the volume of this cell and the transformation of the nucleus into a germinal spot.

In the entodermic cells lining the radial canals the protoplasm is perfectly transparent and devoid of granules; the nucleus appears as a clear round spot containing a central round and denser nucleolus. The cells with their nuclei and nucleoli subsequently increase in size, and the protoplasm becomes more and more granular. The nucleolus, at first simple and furnished with a small vacuole, commences to divide. It lengthens, becomes constricted in the middle, curves into the form of a horse-shoe, and finally divides into two parts, each possessing a central vacuole; each half again divides into two parts, but in a direction perpendicular to the first, and so on.

These phenomena, constant and normal in the Medusæ of the White Sea, are the exception in those from the Bay of Naples. In the latter the division of the nucleus takes place in a different manner. When the nucleolus, after elongation, presents a median constriction, it does not divide into two parts, but simply elongates in the form of a band twisted upon itself; constrictions then forming at several parts, it becomes a long moniliform ribbon rolled up in several turns. Each division of the chaplet is fusiform and round; it regularly contains in the middle a very small vacuole, and is united to the neighbouring divisions by a thin and sometimes rather long articulation. Sometimes this band, which reminds us of the nucleus of some of the Infusoria (*Stentor*, *Spirostomum*), splits into two. Finally the articulations of the chaplet separate, and instead of a nucleolus, there is formed at the centre of the nucleus a group of several dozens of small round balls which collect into a sphere placed at some distance from the walls of the nucleus. These balls continue to divide until they reach several hundreds in number. During all this time the ovum enlarges and attains its definitive diameter, which surpasses nearly twenty times that of the entodermic cells from which it originates.

The perfectly mature ovum before fecundation presents the aspect of a sphere of granular protoplasm with a central and perfectly *uniform* nucleus showing not the slightest trace of a nucleolus. The hundreds of granules into which the nucleolus has been divided have been dissolved in the protoplasm of the nucleus.

**Proportion of Water in the Medusæ.*** — Dr. Krukenberg has already shown that a large specimen of *Rhizostoma Cuvieri* contained 95·392 per cent. of water, with 1·608 of organic and 3·0 of inorganic substances. In order to test the statement of Möbius that *Aurelia aurita* from the Bay of Kiel had been found on analysis to contain 99·82 per cent. of water—a proportion leaving the solid materials at only $\frac{1}{20}$ of the amount determined in a Triest specimen—a single specimen of the same species was analyzed, and also two other *Aureliæ* together. The result showed the solid matters to exist in the proportion of from 4·21 to 4·66 per cent., the water in that of from 95·34 to 95·79. *Chrysaora hyoscella* gives between 95·75 and 96·3 per cent. of water, and from 3·7 to 4·25 of solid bodies. Probably most other Medusæ agree with those selected in these points, so that no marine animal exists having the large proportion of 99·8 per cent. of water as a constituent of its tissues.

**A Fresh-water Hydroid Medusa.**—One of the most startling zoological discoveries of recent years was made in June last in the warm-water tank in which the *Victoria regia* is grown at the gardens of the Royal Botanical Society, London. The water (which has a temperature of 85° to 90° F.) was found by Mr. Sowerby to be literally swarming with little Medusæ of a new genus, about $\frac{1}{3}$ inch in transverse diameter. No true fresh-water Medusa has hitherto been known, the one living in the discharging canal of the Cette salt-works † being the most recent case of the discovery of a species not actually inhabiting the sea.

The Medusæ were examined by Professor Allman, and subsequently by Professor Lankester, and were described by the former under the name of *Limnocodium victoria* (λίμνη, a pond, and κώδων, a bell) in a paper read at the meeting of the Linnean Society on June 17, and by the latter as *Craspedacustes Sowerbii* (in allusion to the relation of its otocysts to its velum) at the Royal Society on the same day.

From Professor Allman's paper ‡ we extract the following:—

The Medusæ are very energetic in their movements, swimming with the characteristic systole and diastole of their umbrella, and in the warm-water tank were apparently in the very conditions which contributed most completely to their well-being.

The *umbrella* varies much in form with its state of contraction, passing from a somewhat conical shape with depressed summit through figures more or less hemispherical to that of a shallow cup or even of a nearly flat disk. Its outer surface is covered by an epithelium composed of flattened hexagonal cells with distinct and brilliant nucleus.

* 'Zool. Anzeig.,' iii. (1880) p. 306. † See this Journal, ii. (1879) p. 582.
‡ 'Nature,' xxi. (1880) p. 178.

The *manubrium* is large; it commences with a quadrate base, and when extended projects beyond the margin of the umbrella. The mouth is destitute of tentacles, but is divided into four lips, which are everted and plicated. The endoderm of the manubrium is thrown into four strongly-marked longitudinal plicated ridges.

The *radial canals* are four in number; they originate each in an angle of the quadrate base of the manubrium, and open distally into a wide circular canal. Each radial canal is accompanied by longitudinal muscular fibres, which spread out on each side at the junction of the radial with the circular canal.

The *velum* is of moderate width, and the extreme margin of the umbrella is thickened and festooned, and loaded with brownish-yellow pigment-cells.

The attachment of the *tentacles* is peculiar. Instead of being free continuations of the umbrella margin, they are given off from the outer surface of the umbrella at points a little above the margin. From each of these points, however, a ridge may be traced centrifugally as far as the thickened umbrella margin; this is caused by the proximate portion of the tentacle being here adnate to the outer surface of the umbrella. It holds exactly the position of the "Mantelspangen" or *peronia*, so well developed in the whole of the Narcomedusæ of Haeckel, and occurring also in some genera of his Trachomedusæ. Its structure, however, differs from that of the true *peronia*, which are merely lines of thread-cells marking the path travelled over by the tentacle, as the insertion of this moved in the course of metamorphosis from the margin of the umbrella to a point at some distance above it, while in *Limnocodium* the ridges are direct continuations of the tentacles whose structure they retain. They become narrower as they approach the margin. The number of the tentacles is very large in adult specimens. The four tentacles which correspond to the directions of the four radial canals or the perradial tentacles are the longest and thickest. The quadrant which intervenes between every two of these carries, at nearly the same height above the margin, about thirteen shorter and thinner tentacles, while between every two of these three to five much smaller tentacles are given off from points nearer to the margin, and at two or three levels, but without any absolute regularity; indeed, in the older examples all regularity, except in the primary or perradial tentacles, seems lost, and the law of their sequence ceases to be apparent.

No indication of a cavity could be found in the tentacles; but they do not present the peculiar cylindrical chorda-like endodermal axis formed by a series of large, clear, thick-walled cells which is so characteristic of the solid tentacles in the Trachomedusæ and Narcomedusæ. From the solid tentacles of these orders they differ also in their great extensibility, the four perradial tentacles admitting of extension in the form of long, greatly attenuated filaments to many times the height of the vertical axis of the umbrella, even when this height is at its maximum; and being again capable of assuming by contraction the form of short thick clubs. Indeed, instead of presenting the comparatively rigid and imperfectly contractile character which prevails among the Trachomedusæ and the Narcomedusæ, they possess as great a power of extension and contraction as may be found in the tentacles of many Leptomedusæ (Thaumantidæ, &c.). These four perradiate tentacles contract independently of the others, and seem to form a different system. All the tentacles are armed along their length with minute thread-cells, which are set in close, somewhat spirally arranged, warts.

The *lithocysts* or *marginal vesicles* are, in adult specimens, about 128 in number. They are situated near the umbrellar margin of the velum, between the bases of the tentacles, and are grouped somewhat irregularly, so that their number has no close relation with that of the tentacles. They consist of a highly refringent spherical body, on which may be usually seen one or more small nucleus-like corpuscles, the whole surrounded by a delicate transparent and structureless capsule. This capsule is very remarkable, for instead of presenting the usual spherical form, it is of an elongated pyriform shape. In its larger end is lodged the spherical refringent body, and it thence becomes attenuated, forming a long tubular tail-like extension which is continued into the velum, in which it runs transversely towards its free margin, and there, after usually becoming more or less convoluted, terminates in a blind extremity.

The *marginal nerve-ring* can be traced running round the whole margin of the umbrella, and in close relation with the otolitic cells. Ocelli are not present.

The *generative sacs* are borne on the radiating canals, into which they open at a short distance beyond the exit of these from the base of the manubrium. They are of an oval form, and from their point of attachment to the radial canal hang down free into the cavity of the umbrella. Some of the specimens examined contained nearly mature ova, which, under compression, were forced from the sac through the radial canal into the cavity of the stomach.

While some of the characters described above point to an affinity with both the Trachomedusæ and Narcomedusæ, this affinity ceases to show itself in the very important morphological element afforded by the marginal bodies. In both Trichomedusæ and Narcomedusæ the marginal bodies belong to the tentacular system; they are metamorphosed tentacles, and their otolite cells are endodermal, while in the Leptomedusæ, the only other order of craspedotal Medusæ in which marginal vesicles occur, these bodies are genetically derived from the velum. Now in *Limnocodium* the marginal vesicles seem to be as truly velar as in the Leptomedusæ. They occur on the lower or abumbral side of the velum, close to its insertion into the umbrella, and the tubular extension of their capsule runs along this side to the free margin of the velum, while the delicate epithelium of the abumbral side passes over them as in the Leptomedusæ. It is true that this point cannot be regarded as settled until an opportunity of tracing the development is afforded; but in very young specimens which Professor Allman examined he found nothing opposed to the view that the marginal vesicles were derived, like those of the Leptomedusæ, from the velum.

If this be the case, *Limnocodium* will hold a position intermediate between the Leptomedusæ and the Trachomedusæ; but as the greatest systematic importance must be attached to the structure and origin of the marginal vesicles, its affinity with the Leptomedusæ must, Professor Allman considers, be regarded as the closer of the two.

Professor Lankester * considers that the animal is one of the subclass Hydromedusæ or Medusæ craspedotæ, and presents the common characters of the order Trachomedusæ (as distinguished from the Narcomedusæ) in having its genital sacs or gonads placed in the course of the radial canals. It agrees with all Tracholinæ (Trachomedusæ and Narcomedusæ) in having endodermal otocysts, and it further exhibits the solid tentacles with cartilaginoid axis, the centripetal travelling of the tentacles, the tentacle rivets (Mantelspangen), the thickened marginal ring to the disk (Nessel ring) observed in many Tracholinæ.

Amongst Trachomedusæ, it finds its place in the Petasidæ, which are characterized as "Trachomedusæ with *four* radial canals, in the course of which the four gonads lie, with a long tubular stomach and no stomach-stalk."

Amongst Petasidæ it is remarkable for the great number of its tentacles, which are *all* solid; and for its very numerous otocysts. Further, it is remarkable among all Hydromedusæ (velate Medusæ, that is, exclusive of *Charybdæa*) for the fact that centrifugal radiating canals pass from the otocysts *into the velum, where they end cæcally*."

The characters of the genus are given, and it is pointed out that the presence of velar otocystic canals constitutes the chief peculiarity of the genus, and may necessitate the formation of a distinct family or sub-order for its reception. The sole character which can be given as specific over and above the generic characters is that of size. The diameter of the disk does not exceed one-third of an inch.

It is exceedingly difficult to trace the introduction of the animal into the tank in the Regent's Park, since no plants have been recently (within twelve months) added to the lily-house, and the water is run off every year. Probably a few specimens were last year or the year before present in the tank, and have only this year multiplied in sufficient abundance to attract attention. Clearly this Medusa is a tropical species, since it flourishes in water of the high temperature of 90° Fahr. Mr. Sowerby has observed it feeding on *Daphnia*, which abounds in the water with it.

Professor Lankester subsequently published † a full preliminary memoir of the animal, illustrated by woodcuts and plates, in which he shows that, contrary to the conclusion of Professor Allman, the tentacles of *Limnocodium* do resemble those of the Trachyline Medusæ in their insertion and in the possession of true (though rudimentary) peronia, also that the statement that the so-called lithocysts or marginal bodies have essentially the same structure as those of Trachyline Medusæ (being modified tentacles with an endodermal axis) is warranted by their developmental history. Consequently he adheres to the original determination of the affinities of the new

* Loc. cit., p. 117. † 'Quart. Journ. Micr. Sci.,' xx. (1880) p. 351.

Medusa as one of the Trachomedusæ, though it is quite a peculiar form, and very possibly is either the isolated representative of an archaic type of that order or has degenerated in connection with its exceptional life-conditions—those of fresh water.

Professor Lankester is fully satisfied that *Limnocodium* develops directly from the egg. When specimens are kept living in a glass jar under constant observation it is found that exceedingly small specimens make their appearance amongst the larger ones. The youngest which he has seen at present measured only $\frac{1}{30}$ inch in diameter, and others were under observation very little larger. The smallest was of a subspherical form, without any aperture to the ectodermal investment. Four minute tentacles were sprouting near one pole of the spherical body, and between these rudiments of four others were seen. Within—the sub-umbrellar musculature was already developed and contracting at intervals. The four radial canals were also present, and, what is more remarkable, the sub-umbrellar cavity was already well marked, and within it the manubrium with the oral aperture. Yet the margin of the umbrella was still closed by a continuous ectodermal coat which, when perforated, would become the velum.

These minute embryos correspond very closely in appearance with the embryos of the well-known typical Trachomedusan *Geryonia*, as figured by Metschnikoff.* They leave no possibility of supposing that *Limnocodium* has, like most Leptomedusæ, a hydroid trophosome. In respect of its development as in other respects, *Limnocodium* is not more closely allied to the Leptomedusæ than to the Trachomedusæ, but is one of the Trachomedusæ.

A remarkable fact which is not yet explained, is the excessive rarity of females. All the specimens which Professor Lankester examined have been males. Females clearly enough must be present, or have been present among the shoals of males—whence the embryos discovered by Mr. Sowerby. It is a known fact among Trachyline Medusæ that in some species males are excessively abundant, and even in some species females have never been detected. Thus again *Limnocodium* agrees with the Trachyline Medusæ.

The exceedingly important fact that some of the Cœlentera and lower kinds of worms digest their solid food by the inception of the solid food-particles into the substance of endodermal cells, each cell behaving as an *Amœba*, has now been fairly established by the observations of Allman on *Myriothela*, Metschnikoff on Turbellarians, and T. J. Parker on *Hydra*. *Limnocodium* exhibits this mode of digestion in the most striking and obvious manner, the endodermal cells of the stomach showing with a power of 800 their amœboid character, and showing further the presence of such food-bodies as *Protococci*, diatoms, and *Euglenæ* in various stages of digestion *within* the protoplasm of single cells and of aggregated groups of such cells.

At the meeting on June 17 of the Linnean Society at which Professor Allman's paper was read, it was suggested that a compromise should be effected between the two names proposed, and that the

* 'Zeitschr. f. wiss. Zoologie,' xxiv. pl. ii. figs. 12 and 15.

Medusa should be called *Limnocodium Sowerbii.* Professor Lankester now writes * that he shall "henceforth speak of the Medusa as *Limnocodium Sowerbii*, Allman and Lankester."

**Physiology of the Fresh-water Medusa.**†—Mr. G. J. Romanes has worked out the physiology of the new form, and gives an interesting account of the results so far obtained.

The natural movements of the Medusa precisely resemble those of its marine congeners. More particularly, these movements resemble those of the marine species which do not swim continuously, but indulge in frequent pauses. In water at the temperature of that in the Victoria Lily-house the pauses are frequent, and the rate of the rhythm irregular, suddenly quickening and slowing even during the same bout, which has the effect of giving an almost intelligent appearance to the movements. This is especially the case with young specimens. In colder water (65° to 75°) the movements are more regular and sustained, so that, guided by the analogy furnished by experiments on the marine forms, he infers that the temperature of the natural habitat of this Medusa cannot be so high as 85°. In water at that temperature the rate of the rhythm is enormously high, sometimes rising to three pulsations per second. But by progressively cooling the water, this rate may be progressively lowered, as in the case of the marine species; and in water at 65° the maximum rate observed was eighty pulsations per minute. As the temperature at which the greatest activity is displayed by the fresh-water species is fatal to all the marine species which he has observed, the effects of cooling are only parallel in the two cases when the effects of a series of higher temperatures in the one case are compared with those of a series of lower temperatures in the other. Similarly, while a temperature of 70° is fatal to all the species of marine Medusæ, it is only 100° that is fatal to the fresh-water species. Lastly, while the marine species will endure any degree of cold without loss of life, such is not the case with the fresh-water species. Marine Medusæ, after having been frozen solid, will, when gradually thawed out, again resume their swimming movements; but this fresh-water Medusa is completely destroyed by freezing. Upon being thawed out, the animal is seen to have shrunk into a tiny ball, and it never again recovers either its life or its shape.

The animals seek the sunlight, congregating at the unshaded end of the tank. Moreover, during the daytime they swim about at the surface; but when the sun goes down they subside, and can no longer be seen, in all these habits resembling many of the sea-water species. They are themselves non-luminous.

On excising the margin of the nectocalyx, the result corresponded precisely with that which is obtained in the case of marine species, the operation producing immediate, total, and permanent paralysis of the nectocalyx, while the severed margin continues to pulsate for two or three days.

A point of specially physiological interest is that in its unmutilated

* 'Nature,' xxii. (1880) p. 191. † Loc. cit., p. 191.

state the fresh-water Medusa exhibits the power of localizing with its manubrium a seat of stimulation situated in the bell. When a part of the bell is nipped with the forceps, or otherwise irritated, the free end of the manubrium is moved over and applied to the part irritated. So far, the movement is precisely similar to that occurring in *Tiaropsis indicans*.* But there is a curious difference; for while in *T. indicans* these movements of localization continue unimpaired after the margin of the bell has been removed, and will be ineffectually attempted even after the bell is almost entirely cut away from its connections with the manubrium, in the fresh-water Medusa the movements cease after the extreme margin of the bell has been removed. For some reason or another the integrity of the margin here seems to be necessary for exciting the manubrium to perform its movements of localization. It is clear that this reason must either be that the margin contains the nerve-centres which preside over these localizing movements of the manubrium, or, much more probably, that it contains some peripheral nervous structures which are alone capable of transmitting to the manubrium a stimulus adequate to evoke the movements of localization. In its unmutilated state this Medusa is at intervals perpetually applying the extremity of its manubrium to one part or another of the margin of the bell, the part of the margin touched always bending in to meet the approaching extremity of the manubrium. In some cases it can be seen that the object of this co-ordinated movement is to allow the extremity of the manubrium—i. e. the mouth of the animal—to pick off a small particle of food that has become entangled in the marginal tentacles. It is therefore not improbable that in *all* cases this is the object of such movements, although in most cases the particle which is caught by the tentacles is too small to be seen with the naked eye. As it is thus no doubt a matter of great importance in the economy of this Medusa that its marginal tentacles should be very sensitive to contact with minute particles, so that a very slight stimulus applied to them should start the co-ordinated movements of localization, it is not surprising that the tentacular rim should present nerve-endings so far sensitive that only by their excitation can the reflex mechanism be thrown into action. But if such is the explanation in this case, it is curious that in *Tiaropsis indicans* every part of the bell should be equally capable of yielding a stimulus to a precisely similar reflex action.

On cutting off *portions* of the margin, and stimulating the bell *above the portions of the margin removed*, the manubrium did not remain passive as it did when the *whole* margin of the bell was removed; but it made ineffectual efforts to find the offending body, and in doing so always touched some part of the margin which was still unmutilated. This fact can only be explained by supposing that the stimulus supplied to the mutilated part is spread over the bell, and falsely referred by the manubrium to some part of the sensitive—i. e. unmutilated—margin.

But to complete this account of the localizing movements it is necessary to state one additional fact which, for the sake of clearness,

* 'Phil. Trans.,' clxvii.

has been hitherto omitted. If any one of the four radial tubes is irritated, the manubrium will correctly localize the seat of irritation, whether or not the margin of the bell has been previously removed. This greater ease, so to speak, of localizing stimuli in the course of the radial tubes than anywhere else in the umbrella except the margin, corresponds with what is found to be the case in *T. indicans*, and probably has a direct reference to the distribution of the principal nerve-tracts.

On the whole, therefore, contrasting this case of localization with the closely parallel case presented by *T. indicans*, it may be said that the two chiefly differ in the fresh-water Medusa, even when unmutilated, not being able to localize so promptly or so certainly; and in the localization being only performed with reference to the margin and radial tubes, instead of with reference to the whole excitable surface of the animal.

All marine Medusæ are very intolerant of fresh water, and therefore, as the fresh-water species must presumably have had marine ancestors,* it seemed an interesting question to determine how far this species would prove tolerant of sea-water. For the sake of comparison the effects of fresh water upon the marine species are first described.† If a naked-eyed Medusa which is swimming actively in sea-water is suddenly transferred to fresh water, it will instantaneously collapse, become motionless, and sink to the bottom of the vessel, remaining motionless until it dies; but if it be again transferred to sea-water it will recover, provided that its exposure to the fresh water has not been too long. It never survives an exposure of fifteen minutes, but may survive an exposure of ten, and generally survives an exposure of five. But although they thus continue to live for an indefinite time, their vigour is conspicuously and permanently impaired. While in the fresh water irritability persists for a short time after spontaneity has ceased, and the manubrium and tentacles are strongly retracted.

Turning now to the case of the fresh-water species, when first it is dropped into sea-water at 85° there is no change in its movements for about fifteen seconds, although the tentacles may be retracted. But then, or a few seconds later, there generally occurs a series of two or three tonic spasms separated from one another by an interval of a few seconds. During the next half-minute the ordinary contractions become progressively weaker, until they fade away into mere twitching convulsions, which affect different parts of the bell irregularly. After about a minute from the time of the first immersion all movement ceases, the bell remaining passive in partial systole. There is now no vestige of irritability. If transferred to fresh water after five minutes' exposure, there immediately supervenes a strong and persistent tonic spasm, resembling rigor mortis, and the animal remains motionless for about twenty minutes. Slight twitching contractions then begin to display themselves, which, however, do not affect the whole bell, but

* Looking to the enormous number of marine species of Medusæ, it is much more probable that the fresh-water species were derived from them, than that they were derived from a fresh-water ancestry.

† For full account see 'Phil. Trans.,' clxvii. pp. 714, 745.

occur partially. The tonic spasm continues progressively to increase in severity, and gives the outline of the margin a very irregular form; the twitching contractions become weaker and less frequent, till at last they altogether die away. Irritability, however, still continues for a time, a nip with the forceps being followed by a bout of rhythmical contractions. Death occurs in several hours in strong and irregular systole.

If the exposure to sea-water has only lasted two minutes, a similar series of phenomena are presented, except that the spontaneous twitching movements supervene in much less time than twenty minutes. But an exposure of even one minute may determine a fatal result a few hours after the Medusa has been restored to fresh water.

Contact with sea-water causes an opalescence and essential disintegration of the tissues, which precisely resemble the effects of fresh water upon the marine Medusæ. When immersed in sea-water this Medusa floats upon the surface, owing to its smaller specific gravity.

In diluted sea-water (50 per cent.) the preliminary tonic spasms do not occur, but all the other phases are the same, though extended through a longer period. In sea-water still more diluted (1 in 4 or 6) there is a gradual loss of spontaneity, till all movement ceases, shortly after which irritability also disappears; manubrium and tentacles expanded. After an hour's continued exposure intense rigor mortis slowly and progressively develops itself, so that at last the bell has shrivelled almost to nothing. An exposure of a few minutes to this strength places the animal past recovery when restored to fresh water. In still weaker mixtures (1 in 8 or 10) spontaneity persists for a long time, but the animal gradually becomes less and less energetic, till at last it will only move in a bout of feeble pulsations when irritated. In still weaker solutions (1 in 12 or 15) spontaneity continues for hours, and in solutions of from 1 in 15 to 18 the Medusa will swim about for days.

It will be seen from this account that the fresh-water Medusa is even more intolerant of sea-water than are the marine species of fresh water. Moreover the fresh-water Medusa is beyond all comparison more intolerant of sea-water than are the marine species of brine; for the marine species will survive many hours' immersion in a saturated solution of salt. While in such a solution they are motionless, with manubrium and tentacles relaxed, so resembling the fresh-water Medusa shortly after being immersed in a mixture of 1 part sea-water to 5 of fresh; but there is the great difference that while this small amount of salt is very quickly fatal to the fresh-water species, the large addition of salt exerts no permanently deleterious influence on the marine species.

We have thus altogether a curious set of cross relations. It would appear that a much less profound physiological change would be required to transmute a sea-water jelly-fish into a jelly-fish adapted to inhab t brine, than would be required to enable it to inhabit fresh water. Yet the latter is the direction in which the modification has taken place, and taken place so completely that sea-water is now more poisonous to the modified species than is fresh water to the unmodified.

There can be no doubt that the modification was gradual—probably brought about by the ancestors of the fresh-water Medusa penetrating higher and higher through the brackish waters of estuaries into the fresh water of rivers—and it would, the author thinks, be hard to point to a more remarkable case of profound physiological modification in adaptation to changed conditions of life. If an animal so exceedingly intolerant of fresh water as is a marine jelly-fish, may yet have all its tissues changed so as to adapt them to thrive in fresh water, and even die after an exposure of one minute to their ancestral element, assuredly we can see no reason why any animal in earth or sea or anywhere else may not in time become fitted to change its element.

### Porifera.

**Sponges of the Leyden Museum.***—In this, the first part of his communication (written in English), Mr. Vosmaer deals with the family of the Desmacidinidæ. As is well known, these and all the siliceous sponges are not only difficult to determine on account of their great variability, but from the technical objection that Bowerbank and Schmidt, two leading authorities, worked almost simultaneously, and altogether independently of one another. After giving the palm to Schmidt, the author describes the symbols he employs in his descriptions, and then passes to a description and enumeration of the species; of these he gives 165, some of which are new, and these he places in sixteen genera, three of which, *Amphilectus*, *Crambe*, and *Hastatus*, are new; the characters of some of the others are emended. The paper seems from the remarks which the author makes on the variability of species, to be a distinct advance on most essays on the subject which have appeared in the English language.

**Structure and Affinities of the Genus Protospongia, Salter.**†—Mr. W. J. Sollas describes the character of the Cambrian genus *Protospongia* from the original and other specimens. In Dr. Hicks's specimen the spicules of the sponge show their original form, when it is clear that they are not fused together into a continuous network; they form a network only by the interlacing of their extremities. The spicules are quadriradiate, with the centre raised, so that each spicule indicates the outlines of a low four-sided pyramid, the centre being at the apex, and the four rays representing the four edges of the pyramid. The rays do not diverge at right angles, and thus the base of the pyramid is oblong, though this may be due to distortion. From some indications the author is inclined to believe that a fifth ray may have sprung from the centre of the spicule downwards. The rays of the spicules appear to be cylindrical. The spicules are generally of several sizes, the larger ones forming a framework which is filled in by the smaller forms, the latter being regularly arranged, so that the smaller ones fill up the square spaces left between the rays of the larger, and thus build up a network of square meshes gradually

* 'Notes R. Mus. Netherlands' (ii. 1880) p. 99.

† 'Abstr. Proc. Geol. Soc. Lond.,' No. 387 (1880) p. 1.

diminishing in size. The sponge-wall seems to have consisted of more than one layer of spicules. The spicules were probably originally siliceous, but now they consist of iron pyrites.

With regard to the systematic position of *Protospongia*, the oldest known sponge, the author remarks that similar spicules similarly arranged are to be met with in the Hexactinellidæ, the absence of one or two rays being not unusual in part of the spicules of true Hexactinellids. As the spicules are free, he would refer the sponge to Zittel's Lyssakina, which are nearly equivalent to Carter's Sarcohexactinellida.

## Protozoa.

**Bütschli's Protozoa.**—The first part of the second edition of the first volume of Bronn's 'Klassen u. Ordnungen des Thier-Reichs,' which contains the Protozoa, has just appeared; it is by Dr. O. Bütschli, of Heidelberg. The part contains only the commencement of the account of the first division (class or subphylum) to which the name *Sarcodina* is given; the limits of the class are not quite the same as those proposed by Hertwig and Lesser, for, as here defined, it consists of three subclasses, Rhizopoda, Heliozoa, and Radiolaria. The bibliography of the first of these recites 118 titles. The four plates contain nearly 70 figures, of which most are taken from the special communications of various authors. It is intended to complete the subject in 12–15 parts, with 30 plates.

**Amœbiform and other new Foraminifera.***—Mr. H. J. Carter describes some specimens dredged up from the Gulf of Manaar, between Ceylon and the southern extremity of India.

Under the head of TESTAMŒBIFORMIA—new group—(*Char.*, amœbiform, testaceous) Mr. Carter says that hitherto almost exclusive attention has been given to the free Foraminifera, whose exquisitely varied forms, although in many instances microscopic, have not unnaturally proved as attractive as the frustules of the Diatomaceæ, so that it has become an object of great search to find out a new form, although it can hardly be seen by the unassisted eye. This to the specialist is a matter of paramount importance, but to the biologist one of insignificance compared with the less attractive and larger forms, which tend to reveal the life-history and connections of the class generally.

For some time past he has anticipated the existence of amœbiform Foraminifera, differentiated only by the peculiarity of their respective pseudopodial expansions; but of course this cannot be ascertained except by minute and laborious examination of the *living* so-called *Bathybius*, which probably abounds with them after the manner of fresh-water Rhizopods, forming a similar slime to that which may often be observed over the bottom of stagnant (i. e. still) fresh-water pools. He was not, however, prepared to find that some of these ever-changing forms were stereotyped as it were by the permanent secretion of a calcareous test, until the specimens from the Gulf of Manaar came under his notice, when he observed two well-characterized

* 'Ann. and Mag. Nat. Hist.,' v. (1880) p. 437.

forms to be very abundant in them, which he describes under the generic names of *Holocladina* and *Cysteodictyina* respectively.

With regard to *Holocladina* (*pustulifera*) it is evident from the form of the test that the living animal possessed an amœboid form; but whether both were developed successively (that is, one part after another like the crust on a stream of lava), or the living animal was fully developed before the test was secreted, there is no evidence now to show, beyond the presumption that the former was most likely the case. The absence of all foreign material in the interior, together with its form, distinctly separates it from the genera *Carpenteria* and *Polytrema*, while it chiefly differs from *Aphrosina** in not being multilocular. No oral apertures were satisfactorily seen; but it may fairly be inferred that each of the conical projections on the terminal branchlets bears one, through which a pseudopodium issues during the living state, in search of that subtile kind of nourishment which the present emptiness of the test indicates to have been the nature of the aliment.

Amongst the other forms described is *Ceratestina*, n. gen. (2 n. sp.), in which the test is horny, of a dark amber colour, and translucent. The composition of the test here brings us one degree nearer than that of the Testamœbiformia to the absolutely naked Foraminifer, to whose conjectured existence the author before alluded; but lest it might be thought that it is merely the chitine without the calcareous material which characterizes this genus, it should be mentioned that if a specimen of *Ceratestina* and an ordinary calcareous test of a Foraminifer together be exposed to the influence of an acid solution (e. g. dilute nitric acid), the latter will be dissolved and leave scarcely any residue, while the former remains unaffected, proving that the horny substance of the *Ceratestina* is something more than the chitine which may support the calcareous material; indeed the best way of extracting a *Ceratestina* is to put the calcareous substance containing the specimen into a strong solution of nitric acid, which, all know, is instant destruction to a calcareous test. In some cases the test is composed in one part of the ordinary calcareous material, and in the other of the horny substance only, which condition is so usually seen in one species that it would appear to be rather natural than accidental. The author alludes to a species which he figured and described, conjecturally, as the "embryonic form" of *Carpenteria monticularis*,† but which now, finding it to be a distinct species, he would name *Carpenteria microscopica*. The chambers of *Carpenteria utricularis* and also the cells of *Polytrema minaceum* are often lined by a stiff horny layer of considerable thickness; but under what circumstances, he is ignorant, as it does not occur always: this, however, is secondary and must not be confounded with *Ceratestina*, in which the horny structure is primary and permanent.

The author also describes as new species *Polytrema cylindricum* and *P. mesentericum*; and as new species or varieties, *Calcarina calcar* var. *hispida* and *Alveolina sinuosa*.

* See this Journal, ii. (1879) p. 500.
† 'Ann. and Mag. Nat. Hist.,' xix. (1877) p. 213.

**Vampyrella lateritia.***—A writer in the 'American Journal of Microscopy' details some observations which he made on this Rhizopod. The animal is in colour reddish-yellow, in general appearance much like the common sun-animalcule, *Actinophrys sol*, but larger, more active in its movements, and with the power to change its form with greater facility. Dr. Leidy's description of it is:—"Animal usually *Actinophrys*-like, with a soft spheroidal body, capable of amœboid variations of form, composed of pale, colourless, granular protoplasm, with abundance of colouring matter, oil-like molecules, and vacuoles. Pseudopods as *Actinophrys*-like rays, *Acineta*-like rays, and digit-like, lobate, or wave-like expansions."

Amongst other details the author says that he saw one individual make its way rapidly across the field of view, and seeming as though some innate knowledge, some rational impulse, were guiding it, for without hesitation the little mass of living jelly passed directly to a filament of *Spirogyra longata* to which it became attached, withdrawing a portion of its rays for the purpose, and conforming itself to the shape of the plant surface. There it had the appearance of resting, stopping the flow of protoplasmic drops along the rays just where each one happened to be. This was at nine o'clock. One minute later, the first turn of the chlorophyll band within the cell suddenly fell down. In another minute the second turn followed; in three minutes, the entire cell-contents were loose and slowly gliding toward the *Vampyrella* which was sucking them in. At five minutes past nine the cell was empty, and the animal moving to the next. Here the same operation was repeated. In its third excursion it placed itself across the partition between two cells, and proceeded to imbibe the contents of both at once. From one the chlorophyll bands were loosened and dragged out in a long strip, while in the other they were broken down into a homogenous green mass and quietly sipped out, the *Vampyrella* visibly swelling. It was not until seven cells were emptied that its appetite was satisfied. A repetition of this was seen in the case of another individual. The creature must, the author thinks, have the power to secrete a fluid capable of dissolving the cellulose, and of acting upon the chlorophyll and protoplasm within the Alga, besides its very evident ability to remove the latter without first dragging them out, or surrounding them *Amœba* fashion. When the seventh cell had been cleaned out the *Vampyrella* transferred itself to a filament of another species of the same genus, where it again rested, but did not feed, with two short blunt pseudopods protruding as if clinging to the plant.

Two days later the field contained a cyst presenting three very distinct lines dividing it into as many parts. Almost as soon as seen, the *Vampyrellæ* began to escape, two making their exit at opposite sides simultaneously, the third which the sac contained following through one of the apertures already made. The process was a rapid one. A thick colourless pseudopod appeared first. Hardly did it touch the wall before the opening was made. The ray-like pseudopods were protruded before one-third of the animal had escaped. Many

* 'Am. Journ. Micr.,' v. (1880) p. 105.

of the dark spots upon the cyst walls, probably of excrementitious matter, followed as free granules, others remaining behind.

**Acinetæ.***—In continuation of his previous note,† Mr. W. G. Cocks states that he is satisfied the perfect forms of *Acinetæ* which he observed in large numbers on the filaments of an Alga, were in fact developed from some rudimentary, gelatinous-looking masses throwing out fine radiations or pseudopodia (or more properly, perhaps, the Amœboid forms of *Acinetæ*), found by Mr. Badcock in the autumn—the masses having disappeared, and the swarms of perfect *Acinetæ* taking their place on the one identical Alga only. The development was not, however, actually observed.

Mr. Cocks also traced the development of an *Acineta* from the ciliated "swarm-germ" emitted by an adult specimen, through the short pedicellate form, and that which has been described as *Podophrya fixa*, back to the perfect *Acineta*. He also satisfied himself that these organisms are not steps in the life-history of any of the species of *Vorticella*, *Epistylis*, &c., but are distinct organisms.

---

## BOTANY.

### A. GENERAL, including Embryology and Histology of the Phanerogamia.

**Disengagement of Carbonic Acid from Roots.**‡—M. Cauvet, of Lyons, has made a fresh series of experiments on this subject. The general conclusions arrived at are that carbonic acid is disengaged in smaller quantity during the night than during any part of the day; that it augments during the morning and diminishes towards evening; the amount disengaged during the night being not more than one-fourth of that emitted during the three periods of the day. This difference he believes to be mainly due to the action of light, which greatly promotes respiration; all the functions of the plant, especially transpiration and respiration, being much less active by night than by day.

**Sensitiveness in the Acacia.**§—In September last Dr. T. L. Phipson made some experiments on the development of sensibility in the common Acacia, *Robinia pseudacacia*. The subject was a fine tree, five or six years old, with luxuriant foliage.

The first experiment was made at 5.30 on the evening of September 17th, the wind being S.S.E., the temperature 17° C., and the sun clear. The leaves were sent to sleep, whilst still brilliantly lighted by the sun, by submitting the terminal leaflet to a series of taps with the finger. After from ten to twenty smart taps the other leaflets commenced to close, and at the end of *five minutes* were all "*asleep*." The lateral leaflets folded up *one after another*, commencing with that nearest to the point of the leaf, i. e. the part struck.

* 'Sci.-Gossip' (1880), p. 155. † *Ante*, p. 470.
‡ 'Bull. Soc. Bot. France,' xxvii. (1880) p. 43.
§ 'Comptes Rendus,' xc. (1880) p. 1228.

The following day at 12.30 this experiment was repeated with a like result, the leaves, the terminal leaflet of which was struck, going to sleep in the space of *four and a half minutes.* It took, however, *two to three hours*' sunlight to restore the lateral leaflets to their former horizontal position.

This falling down one after the other of the leaflets, commencing from the extremity of the leaf, is exactly similar to what is observed in the sensitive plant, in which, as the author showed in 1876,* there is simply the development in the highest degree of a phenomenon which is traceable throughout the whole vegetable kingdom.

The application of a strong heat to the terminal leaflet, which acts immediately on the sensitive plant, produced no effect on the lateral leaflets of the *Acacia*, even when the terminal leaflet was crisped and burnt by a small flame. This seems to the author to demonstrate that the sap is much less mobile in the tissue of the one plant than in that of the other.

**Copper in Plants.**†—In a recent memoir,‡ M. Dieulafait showed that copper exists in a state of complete diffusion in all the rocks of the primordial formation, and in those resulting directly from their destruction. Among other consequences of this, all plants which grow on such rocks should contain copper in sensible proportion.

M. Dieulafait has tested this view, and the following are the results of his investigations:—

Copper exists in all plants which grow on rocks of the primordial formation. Its proportion is sufficient for it to be recognized with certainty, even with the ammonia-reaction, by using only 1 gramme of ash.

Each of the one hundred and twenty-eight specimens of white oak of marly strata showed the presence of copper with 1 gramme of ash, though, in general, the proportion of the metal was less than that in plants of primordial strata.

All the specimens obtained in dolomitic horizons furnished copper distinctly recognizable in 1 gramme of ash; but there were great variations according to the specimens.

The plants which live on comparatively pure limestones did not furnish any traces of copper under the conditions of the three foregoing groups. To be able to recognize it with certainty, it was necessary sometimes to use as much as 100 grammes of ash.

Does copper exist normally in organs of animals and in those of man? The facts brought out in the present and previous memoir naturally led up to this question, which is shown to be less simple and absolute than has been believed hitherto. M. Dieulafait hopes shortly to communicate facts as to animals and man living on the primordial formation.

* 'Familiar Letters on some Mysteries of Nature,' &c., p. 139.
† 'Comptes Rendus,' xc. (1880) p. 703.
‡ 'Annales de Chimie et de Physique,' 5th ser., xviii.

**Action of Ozone on the Colouring-matters of Plants.***—In some experiments by Mr. A. R. Leeds, in which many varieties of flowers were exposed during nineteen hours to the action of a current of 152 litres of air, containing in all 228 mgr. of ozone, the bleaching effected was extremely imperfect. When 1200 litres of air were passed over various flowers (total ozone, 1·8 grains), they were partly or wholly bleached at the end of five days. A piece of calico with a pattern in bright green and black was completely bleached during the same interval, the green having disappeared completely, and the stain of the mordant only remaining where the black had been.

From these and other results it is concluded that the colouring-matters of both leaves and flowers of the species (*Lantana*, *Fuchsia*, *Petunia*, *Rosa*, *Verbena*, *Pelargonium*, *Bouvardia*, *Euphorbia*, &c.) experimented with were partly or wholly destroyed by ozone; but a considerable percentage of ozone is required to produce this result, or if such small amounts as are obtained in the customary methods of ozonizing air by phosphorus are employed (1 to 3 mgr. per litre) a large volume of ozonized air must be used, and a considerable interval elapse before bleaching is effected.

**Red Colouring-matter of the Leaves of the Virginian Creeper.**†
The red autumn leaves of the Virginian creeper give up to alcohol a beautiful rose-red pigment, which is coloured green by a weak solution of potash, the red colour being again restored by very dilute sulphuric acid. Berzelius has already shown that the green pigment is different from that of chlorophyll-grains, which is strikingly proved, according to Schnetzler, by the following experiment:—

1 volume of water, 1 volume of the red alcoholic solution, and ½ volume of sulphuric acid are slightly agitated together. After a short time a beautiful green solution in ether with red fluorescence floats on the top of the solution of the true chlorophyll-pigment. The red pigment of the leaves of the Virginian creeper, separated from the colouring-matter of the chlorophyll, is dissolved in the mixture of alcohol and water. It is changed to green by a solution of potash, but is not then fluorescent.

**Chemical Composition of Aleurone-grains.**‡—Dr. Vines continues the account of this investigation, which appeared in 1878.§ It was therein shown that the aleurone-grains of the lupin consist of three proteid substances, namely, of two globulins—the one belonging to the myosin group, the other to the vitellin group—and of a substance, allied to the peptones, provisionally termed hemialbumose. In the present communication the results of the investigation of the grains of the peony and of the castor-oil plant (*Ricinus*) are given. The grains of the peony are found to be readily soluble in distilled water. Treatment with 10 per cent. NaCl solution, however, proves the existence of a myosin-globulin. Apparently no vitellin-globulin is

* 'Chem. News,' xl. (1879) p. 86. See 'Journ. Chem. Soc.,' Abstr., xxxviii. (1880) p. 58.
† 'Bot. Centralbl.,' i. (1880) p. 247.
‡ 'Nature,' xxii. (1880) p. 91. § 'Proc. Roy. Soc.,' xxviii. (1878) p. 218.

present. The grains contain hemialbumose in considerable quantity. The grains of *Ricinus* present a complex structure. They consist of a mass of ground-substance of proteid nature, enclosing a crystalloid of proteid substance and a globoid which consists of inorganic matter. The ground-substance is found to be composed, like the grain of the lupin, of the two globulins and of hemialbumose. The chemical nature of the crystalloid is not so clearly made out. It is slowly soluble in 10 per cent. NaCl solution, and readily soluble in 20 per cent., or in saturated NaCl solution after treatment with alcohol. The crystalloids of several plants were investigated with the view of ascertaining their relative solubility in solutions of this salt. Those of *Viola elatior* and of *Linum usitatissimum* were found to resemble those of *Ricinus* in this respect; those of *Bertholletia* and of *Cucurbita* are readily soluble in 10 per cent. and saturated NaCl solutions; those of *Musa ensete* and *Hillii*, and those of *Sparganium ramosum* are either insoluble or only partially soluble in these solutions.

The points of more general interest are the action of alcohol in promoting the solution of the crystalloids of *Ricinus* in 20 per cent. and in saturated solutions of NaCl, and the fact that long-continued exposure to alcohol does not render the vegetable globulins insoluble in these solutions.

The author finally expresses his opinion that the caseins which Ritthausen has extracted from various seeds consist to a considerable extent of precipitated hemialbumose.

**"Cistoma."** *—Under this term Gasparrini formerly described a membranous sac which he claimed to have observed beneath the semilunar guard-cells of the stoma, continuous with the cuticle of the epidermis and of the guard-cells. Other botanists not having confirmed this observation, A. Mori has endeavoured to set the question at rest by a very careful examination, chiefly made on the stomata of *Cereus peruvianus*, *Ficus elastica*, *Yucca aloëifolia*, *Aloë vulgaris*, *Euphorbia officinarum*, *Anthurium Scherzerianum*, *Agave americana*, and other plants. His observations tend to the conclusion that the description of the "cistoma" is founded on a mistake. He finds the cells at the bottom of the stomatic cavity destitute of any cuticular lining, the walls of these cells consisting entirely of cellulose, and being in immediate contact with the air which penetrates the stomatic cavity. The cuticle which is continuous with the superficies of the epidermis invests the stomatic cavity only.

**Apical Growth with several Apical Cells.**†—Various authors have ascribed a number of apical cells to the roots of Marattiaceæ and Ophioglossaceæ, the apices of the stems of *Selaginella*, and the branches of Fucaceæ.

According to the accurate definition of the apical cell given by Schwendener, only a single or several equivalent cells can be so regarded which are grouped immediately around the centre of the apical point, and which maintain this position during the apical growth. But some of the daughter-cells which result from the

* 'Nuov. Giorn. Bot. Ital.,' xii. (1880) p. 148.
† 'SB. Ges. naturf. Freund. Berlin,' 1879.

division of apical cells lose this position, and are not correctly regarded as apical cells, even if still situated near the centre. The number of apical cells may indeed be more than one, but as can be proved on mechanico-geometrical grounds, not so large as Russow claims for the roots of Marattiaceæ. This writer states that he has, on a longitudinal section, observed as many as from seven to ten apical cells; Schwendener never found more than two in *Marattia*, lying right and left of the median line. The complementary transverse section shows altogether four apical cells. Russow appears not to have observed the true apex of the root, but a section of the root-cap. The four apical cells do not touch at one point, but two of them form an edge.

Foliage shoots of *Juniperus communis*, seedlings of *Pinus inops*, *P. Laricio, P. sylvestris*, and *Abies alba*, also show four apical cells, two opposite ones forming again an edge.

## B. CRYPTOGAMIA.

### Cryptogamia Vascularia.

**Structure of the Fructification of Pilularia.***—According to recent researches of Juranyi, the fructification of *Pilularia globulifera* is a leaf-segment of peculiar form. At the time of its formation, in addition to the simple sterile foliage-leaves, other bifid leaves are formed, the anterior segment of each of which becomes a sporangium, the posterior segment developing in the ordinary manner of foliage-leaves, appearing at an earlier stage as a lateral lobe of the fertile segment. The chief ground for this opinion is that the tissue of the pedicel of the fructification always passes over at once into that of the leaf situated behind it.

The first appearance of the entire young fructification is that of small cylindrical masses of tissue, which subsequently assume an obtuse fusiform shape, the thin-walled cells being filled with strongly refractive protoplasm. In the centre of this tissue the procambial bundle can soon be detected, out of which the vascular bundle of the fructification is developed. At first this mass of tissue grows in length nearly uniformly; but subsequently the lower side grows more rapidly, in consequence of which the apex of the structure is elevated, and appears concave on the side which faces the sterile leaf. With this curvature it assumes a club-like form, and forms the pedicel of the now developing sporocarp. On this are formed subsequently four sickle-shaped leaf-segments, from which the principal part of the fructification is developed, and which form its valves. They are placed in opposite pairs, in such a way that their concave side faces the centre, the convex side lying on the outside. At an early period the apices of the separate leaf-segments can be distinguished, and soon afterwards the cavities (lacunæ sorales) in which the sporangia are formed. The margins of the two growing leaves finally coalesce, while their free apices still continue their growth. After the coalescence of the segments the young fructification is pear-shaped.

* 'SB. Ungar. Akad. d. Wiss.,' 1879, No. 5, p. 111 (Hungarian). See 'Bot. Centralbl.,' i. (1880) p. 207.

The line of coalescence of the inner margins of the leaf-segments coincides with the central axis of the mature fruit. The four crossed rows of cells which are visible on transverse section, and the signification of which has hitherto been obscure, are, according to this view, simply indications of the coalescence of the adjacent leaves. By the thickening of the walls of the superficial cells of the fructification, which finally becomes nearly globular, the soral cavities having closed up, the lines of contact of the leaf-segments become at length completely obliterated.

### Muscineæ.

**British Moss-Flora.**—Dr. R. Braithwaite, of well-known bryological reputation, has commenced the publication of monographs of the families of British mosses, each complete in itself and illustrated by plates of all the species, with microscopical details of their structure. Part I. includes the Andreæaceæ, and Part II. the Buxbaumiaceæ and Georgiaceæ, each with two plates, drawn by the author.

The cell-structure of the leaves, so important in the distinction of genera and species, receives due attention both in the figures and descriptions. The records of localities for all but the common species are intended to be numerous, and the bibliography ampler than any that has hitherto appeared in a British work.

The arrangement of the families and genera is principally in accordance with that suggested by Professor Lindberg,* the most natural that has yet appeared. In this the Cleistocarpous mosses are regarded as imperfectly developed forms of various Stegocarpous families, with which they agree in everything but a separable operculum, and the genera are framed on a broader and more rational basis, just as our best botanists now deal with Phænogamous plants. Professor Lindberg's terms for the position of the reproductive organs are also adopted.

Bryologists well know how much a work of this kind is required, Wilson's 'Bryologia Britannica' being unobtainable except at a largely enhanced price, and being now altogether insufficient as a guide to our recently much-extended Moss-Flora.

### Characeæ.

**British Characeæ.**†—Messrs. H. and J. Groves have compiled a much-needed monograph of the British species of Characeæ, accompanied by four good plates. The total number of species (besides two doubtful ones) is nineteen, all previously described. The order is first divided, as is usually done, into the two sections Chareæ and Nitelleæ (called by Groves Charæ and Nitellæ—objectionable terms, as being simply the plurals of the generic name), each including two genera, *Chara* and *Lychnothamnus*, *Tolypella* and *Nitella*. Of *Chara* nine British species are described, divided into three series,

* 'Utcast till en naturlig Gruppering af Europas Bladmossor med toppsittande Frukt,' 1878.

† 'Trimen's Journ. Bot.,' ix. (1880) p. 97.

Triplostichæ, Diplostichæ, and Haplostichæ, characterized by the stem having respectively three times, twice, and the same number of cortical cells as branchlets in the whorls. *Lychnothamnus* includes only one, *Tolypella* numbers three, and *Nitella* six British species.

### Fungi.

**Formation of Fat in Fungi.***—The fat formed in vegetable cells is known to be of the nature of a secretion, and not a product of fermentation; it is found in quantity varying with the activity of the growth and of the oxygen-respiration (? assimilation) of the plant. It may probably originate from the splitting-up of proteids in the cells of *Penicillium* and other fungi. The relation of the formation of fat to the nutrition of the plant remains still altogether obscure.

A recent series of experiments by Nägeli and Loew on *Penicillium* has been directed chiefly to investigate the degree in which various nutrient substances affect the formation of fat. These they arrange in this respect in the following series, advancing from those less to those more favourable:—(1) ammonium acetate; (2) ammonium tartrate and succinate, and asparagine; (3) leucine; (4) peptone; (5) ammonium tartrate plus sugar; (6) leucine plus sugar; (7) peptone plus sugar.

**Secretion from a Fungus.**†—M. Eug. Fournier has observed on a species of *Polyporus* (probably *P. cuticularis*) growing on a plum-stem in his garden at Auteuil, an acid viscid secretion, which begins to be exuded daily as soon as the pileus is exposed to the full rays of the sun, about 9 A.M., and continues through the day until and beyond sunset. In 100 parts of the fluid were found to be contained, on chemical analysis, 0·545 parts of organic matter, and 0·665 parts mineral matter, in all 1·21 parts of residue. Of albuminoid substances coagulated by heat there were 0·03 parts, and of glucose 0·32 parts. The residue on calcination was strongly alkaline, and effervesced with acids. It consisted of lime and potassa in combination with sulphuric, hydrochloric, and phosphoric acids.

**Anthracnose of the Vine.**‡—This disease, known in France as "brûleur noir" and in Germany as "Brenner," and widely spread through the south of Europe from Portugal to Greece, has been made a subject of careful study by M. Prillieux. He identifies it with the various organisms described under the names of *Sphaceloma ampelinum* by De Bary, *Ramularia ampelophaga* by Passerini, *Phoma uvicola* by Arcangeli, and *Glœosporium ampelophagum* by Saccardo, this last producing the disease known in Italy as "vajuolo."

The disease is indicated by very definite characters: spots of a dark brown colour, somewhat depressed in the centre. These spots appear in great numbers on the young branches, tendrils, leaves, and berries; they penetrate and completely destroy the tissue in the places where they are developed; they increase at their circumference,

* 'Journ. prakt. Chem.,' xx. p. 97. See 'Journ. Chem. Soc.,' Abstr. xxxviii. (1880) p. 837.

† 'Bull. Soc. Bot. France,' xxvi. (1879) p. 324

‡ Ibid., p. 308.

and frequently coalesce with one another. Ultimately the ends of the branches present the appearance of having been burnt; the berries shrivel up or drop. The spores are produced in great abundance, and are colourless, transparent, and oblong in shape. They germinate very freely in water.

Prillieux adopts for this fungus Saccardo's name *Glœosporium ampelophagum.* He is inclined to think that it is not identical with the fungus which produces the well-known "black rot" of the American vines, *Phoma uvicola*, and that it is probably not due to American importation.

In commenting on the above observation,* M. Cornu disputes Prillieux's statement that the disease has been known both in Germany and France for a long period, even a century. He is disposed to identify it with the American "black rot," and to consider that it has been introduced into Europe with American stocks.

M. Prillieux, in a subsequent communication,† gives further reasons for doubting the identity of the anthracnose with the American "black rot."

**Urocystis Cepulæ.**‡—M. Cornu has made some further observations on the fungus which causes the disease so destructive to the onion crop in America, in addition to those already recorded.§ In reference to Dr. M. C. Cooke's identification of the species with *U. Colchici*, he points out that a number of instances are known in which the same host-species is attacked by two or more species of fungus all belonging to the Ustilagineæ. M. Cornu finds that the parasite cannot attack the tissue of the host when the plant has attained to any considerable size; but that it would be in danger of spreading with alarming rapidity by attacking very young seedlings if the crop were grown year after year on the same soil. This he believes to be the reason why it has been so destructive in America, and has not yet attained any great dimensions in Europe. The safety of the crop depends on the transplantation of the seedlings, and the destruction of all that appear weakly or sickly.

**Sterigmatocystis and Nematogonum.**‖—M. G. Bainier gives a detailed account of the structure of these two genera of fungi. Of *Sterigmatocystis* he describes seven comparatively large species, in which the sterigmata are very much shorter than the basidia, including one new one, *S. carbonaria;* and five minute species in which the sterigmata are equal to or larger than the basidia. All these were found on various drugs. The description of *Nematogonum aurantiacum* is taken from specimens found on the clippings of a shoemaker's shop.

**Mycotheca Marchica.**—Under this title, Zopf and Sydow are publishing a myco-flora of the province Brandenburg in Prussia, the

* 'Bull. Soc. Bot. France,' xxvi. (1879) p. 319.
† Ibid., xxvii. (1880) p. 34. ‡ Ibid., p. 39.
§ See this Journal, ii. (1879) p. 921, and *ante*, p. 307.
‖ 'Bull. Soc. Bot. France,' xxvii. (1880) p. 27.

first century of which is already issued. Six new species are described, viz. *Cyphella pezizoides*, *Puccinia Sydowiana*, *Sclerotinia Batschiana*, *Chætomium botrychodes*, *Entyloma bicolor*, and *Thielavia basicola*. In addition to a complete enumeration of the myco-flora, the work will contain also a treatise on the classification of fungi.

**Ceriomyces terrestris.***—The fungus previously described under this name by Schulzer of Müggenburg, and referred by him to Corda's genus *Ceriomyces*, is stated by the same authority to have been erroneously so referred, and to belong in reality to the genus *Dædalia*. He has now found it in three distinct forms, differing greatly in appearance and habit, but always retaining a uniformity in the size and form of the spores, nearly spherical, and from 3 to 7 mm. in diameter. From this peculiarity he proposes for it the amended name *Dædalia polymorpha*. He considers it to be a transitional form between the Clavariacei and the Pileati.

**Vine-pock.**†—Under the name of "Pocken-krankheit" is known a disease of the vine caused by the parasitic fungus *Glœosporium ampelophagum*, which has appeared since 1876 in Italy and the southern provinces of Austria, and which often destroys a fourth or even a half of the crop. The fungus forms brown spots, with a grey or reddish bloom in the centre, which are at first nearly circular, but subsequently often coalesce. They consist of several layers of pale brown polyhedral cells, which are colourless above, and are there narrowed into short sterigmata or conidiophores. The conidia (spores) are short, elliptical or ovate, colourless, 5–6 mm. long, and 2·5–3·5 mm. broad. The development and rapid spreading of the fungus depends on the conditions of moisture. It is recommended to remove and burn the infected parts.

**Prehistoric Polyporus.**‡—Von Thümen describes a piece of a *Polyporus* collected, among other prehistoric objects, in the pile-dwelling station in the neighbourhood of Laibach. The state of the preservation was sufficient for the structure to be made out without difficulty, and for the fungus to be identified with the existing *Polyporus fomentarius*. It may have grown on a tree in the station itself, or have been brought in from outside by the inhabitants to be used for the purpose of tinder.

**Relationship of Ozonium to Coprinus.**§—O. Penzig has carefully investigated the history of the structure known as *Ozonium* Lk.; and has come to the conclusion that under the name of *Ozonium auricomum* have been united a number of bodies all of which consist of sterile mycelia of various stages of *Coprinus*, which greatly resemble one another, but which exhibit minute differences in their size, the diameter of the hyphæ, the transverse septation, &c. From among them he proposes to establish a new species, *Coprinus intermedius*.

* 'Oester. bot. Zeitschr.,' xxx. (1880) p. 144.

† 'Die Pocken des Weinstockes,' von F. von Thümen, Vienna, 1880. See 'Bot. Centralblatt,' i. (1880) p. 176.

‡ 'Verhandl. zool.-bot. Ges. Wien,' xxix. (1880) p. 52.

§ 'Nuov. Giorn. Bot. Ital.,' xii. (1880) p. 132.

**Disease of the Apple-tree caused by Alcoholic Fermentation.***—M. Van Tieghem calls attention to the conclusion resulting from M. Müntz's observations, that alcoholic fermentation is always the result of a single condition, viz. when a living cell is asphyxiated or deprived of oxygen in the presence of sugar. He finds precisely the same conditions occurring in nature in a disease of the roots of the apple-tree observed by M. Des Cloizeaux in Normandy. The roots, which were very old, exhaled a strong alcoholic odour. On examination it was found that neither the fibrovascular bundles nor the vessels exhibited any deterioration, the mischief being confined to the cells of the medullary rays and of the woody parenchyma. In these the ordinary contents had been entirely replaced by brown globules, alcohol being formed abundantly in these cells, and spreading through the tissues. No trace of microphytes of any kind was observed. The alcohol had evidently taken the place of ordinary sugar and starch; and its formation appeared to be due to a want of oxygen in the soil. The season had been remarkably rainy, and the disease was considerably abated by draining the soil or by digging trenches round the root.

**Saccharomyces apiculatus.†**—E. C. Hansen draws attention to the inquiry of Brefeld, What is the original source in nature of the germs of fungi which are efficacious in the process of fermentation? and attempts to give an answer to this question in the case of *Saccharomyces apiculatus* of Reess and Pasteur. This fungus he finds to be widely distributed on ripe, sweet, succulent fruits, from which it is dispersed by the wind; it occurs also on unripe fruits, but soon perishes from want of nutriment. Rain and the fall of the ripe fruit bring it to the ground, where it passes the winter, germinating in the following summer.

*S. apiculatus* does not, like *S. cerevisiæ* and other ferments, cause the production of inversion, and is therefore unable to induce fermentation in saccharose, such as a solution of cane-sugar. It corresponds in this respect to certain Mucorini, and is a far less active ferment than the other species of *Saccharomyces*.

**Plasmodia of Myxomycetes.**—In October 1879, the Rev. H. H. Higgins collected some fragments of decaying bark and wood on which were growing five or six kinds of *Myxomycetes*. The specimens were placed on a bed of wet sand under a bell-glass, for observation.

In about three weeks, upon the fragment on which were some small portions of *Fuligo varians* Sommf (*Æthalium*), was developed a bed or cushion of olive-brown jelly, highly charged with granules; length about 30 mm., breadth 10 mm., depth 3 or 4 mm. The zoospores had not been noticed previously to their union in a compact plasmodium. The plasmodium was repeatedly observed both as a whole and in detached portions; but it was very sluggish, and the only way in which motion could be detected was by getting a view of the mass under an oblique light, when some slight changes could be

* 'Bull. Soc. Bot. France,' xxvi. (1879) p. 326.
† 'Hedwigia,' xix. (1880) p. 75.

noticed in the reflections from its surface. Its margin presented no peculiar features.

Its sluggishness was supposed to be due to its being gorged with food; and, to test this inference, a portion of the plasmodium was placed in a drop of water on an ordinary glass slide. It soon became diffused, filling the drop with a granular jelly, perceptibly brown in colour though paler than the mass from which it had been taken. Still, no movements could be seen, and signs of its irritability were altogether obscure.

To eliminate as far as possible the results of satiety, the water in the drop was evaporated till the drop became a gummy or viscid patch. A second drop of pure water was then placed on the slide, the edge of the drop being about 3 mm. from the margin of the viscid patch. The water in the drop was then led to the edge of the patch, forming a narrow neck of water between the two. In about four hours the protoplasm of the patch had begun to pass through the neck, leaving all the granules behind, and was gathering in a mass on one side of the drop. The protoplasm and the water were alike perfectly pure and colourless. The edge of the protoplasm could only be discerned by a difference between the refractive power of the water and that of the protoplasm, now highly saturated with water. Why the protoplasm kept itself together, and why it seemed to choose one side of the drop, must be left unexplained; but when the protoplasm had filled rather more than half the drop, its margin on the growing edge was as sharply definite as the outline of the queen's head on a new sixpence. Well-known amœboid projections were there, and others unfamiliar. The protoplasm was now evidently in a starved condition, and was putting out feelers for food. The feelers had slow motion, but the author was unable to observe the circulation which must have been going on in the narrow neck. Traces of extremely delicate interrupted lines could be seen on the surface of the protoplasm, apparently diverging from the narrow neck.

Before another opportunity offered for repeating the experiment, some change took place in the plasmodium, and further attempts failed.

### Lichenes.

**Epiphora.***—This genus of lichens was established by Nylander† out of *Parmelia encausta*, and, as Minks believes, on insufficient grounds. He considers Nylander's *Epiphora encausta* to be a true lichen, which, however, in consequence of unfavourable vital conditions forms neither gonidia nor gonangia, and not even the true hyphal tissue and apothecia; so that it cannot even be separated as a distinct species, much less genus.

Nylander's genus *Magmopsis* has also, according to the same authority, been founded on insufficient data.

**Lichens of Mont-Dore and Haute-Vienne.**‡ — An important analytical catalogue of the Lichens of these two departments by Lamy

* 'Flora,' lxiii. (1880) p. 105. † Ibid., lix. (1876) p. 238.

‡ 'Bull. Soc. Bot France,' vol. xxv. 1878 (1880) p. 322. See 'Revue Mycol.,' ii. (1880) p. 106.

de la Chapelle, occupying 215 pages, has just been published. In its arrangement it recalls that of Dr. Nylander's 'Synopsis.' The author has grouped 631 species or subspecies. 204 are common to the two districts; 109 are peculiar to Mont-Dore, and 318 to Haute-Vienne—that is, the former has 313 lichens, and the latter 522.

Of the 119 species peculiar to Mont-Dore, 14 are entirely new, and are:—*Stereocaulon curtulum*, *S. acaulon*; *Parmeliopsis subsorediaus*; *Pannaria triptophylliza*; *Lecanora subintricans*; *Lecidea aglœiza*, *L. instrata*, *L. planula*, *L. præcontigua*, *L. badio-pallens*, *L. badiopallescens*, *L. instratula*, *L. umbriformis*, *L. thiopholiza*. 17 others are new to France.

With regard to the 522 species of Haute-Vienne, 36 are new, viz.:—

*Ephœbe intricata*; *Collema chalazanellum*; *Collemopsis coracodiza*; *Stereocaulon acaulon*; *Lecanora scotoplaca*, *L. nigrozonata*, *L. submergenda*, *L. immersata*, *L. liparina*, *L. Riparti*, *L. conizella*; *Pertusaria leucosora*, *P. flavicans*; *Urceolaria violaria*; *Lecidea submersula*, *L. acervulans*, *L. terebrescens*, *L. acclinoides*, *L. albuginosa*, *L. chrysoteichiza*, *L. segregula*, *L. pauperrima*, *L. girizans* v. *opegraphiza*, *L. Richardi*, *L. conioptiza*, *L. modica*, *L. crepera*, *L. griseo-nigra*, *L. sequax*, *L. gymnomitrii*; *Melaspilea deviella*; *Endocarpon leptophyllodes*; *Verrucaria Mortarii*, *V. chlorotella*, *V. viridatula*, *V. faginella*, and 35 others.

The catalogue is followed (1) by some notes on the geographical distribution of the species and the nature of the substratum: the author records, amongst other remarkable facts in botanical geography, the presence on the central plateau of France of *P. aquila*, which usually frequents the sea-shore; (2) by a glossary of some technical words frequently employed in Lichenography; and (3) concluding with an alphabetical table referring to the numbers in the catalogue.

### Algæ.

**Morphology of Florideæ.***—The subjects treated of in Agardh's most recent work on the Florideæ are as follows:—

I. The general appearance and external parts of the Florideæ. (1) General appearance. (2) Increase and branching of the external parts. (3) The root and the formations belonging to the root-system. (4) The stem. (5) Branches and leaves.

II. The structure of the Florideæ. (6) Nature of the cell-membrane and cuticle. (7) The cell-contents in various stages of development, and in different layers of the thallus. (8) The connection between the various cells, and the means by which this is effected. (9) The various processes of cell-formation. (10) Relationship of position and grouping of the cells; their union into different layers.

III. Organs of reproduction. (11) The antheridia. (12) The sphærospore-fruit and sphærospore. (13) The cystocarp or capsular fruit. (14) Views in relation to the so-called double fructification.

* "Florideernas Morphologi," 'Sv. Vetenskaps-Akad. Handl.,' xv. (1879) No. 6. See 'Bot. Centralbl.,' i. (1880) p. 33.

**Bilateralness in Florideæ.***—In contradistinction to the ordinary multilateral structure of the Florideæ, some instances of bilateral structure have been described by Nägeli and Kny in the genera *Herposiphonia* and *Dasya*. These and other examples have now been more closely examined by Ambronn.

The nature of the bilateralness is different in these two genera; in the former we have an instance of monopodial, in the latter of sympodial ramification.

In the first species described, *Rytiphlœa pinastroides*, the apex of the stem is strongly curved inwards, the axis of the stem grows by means of an apical cell from which nearly cylindrical segments are cut off, breaking up into five peripheral and one central cell. The lateral organs are leaves and axes. The leaves stand in a single plane upon the convex, the axes in two planes on the concave side. The leaves have a limited, the axes in general an unlimited power of growth. The former consists of undivided, the latter of segmented cells. The leaves branch in a pseudo-dichotomous manner, the number of ramifications being at most six; the ramification of the axes generally proceeds to the fifth order. Growth by enlargement of the cells commences in the leaves at the apex, advancing to the base, in the axes in the reverse order. Both those divisions by which the segments break up into five peripheral and one central cell, and those which result in the formation of the cortex, commence on the convex, and advance equally on both planes to the concave side.

*Rytiphlœa tinctoria* differs from *R. pinastroides* mainly in the outline of the stem being elliptical instead of circular. The branching also goes on to the seventh degree.

In *Helicothamnion scorpioides* the axis has a strongly incurved cone of growth as long as it is in active growth. The lateral structures are exclusively axes, and stand alternately right and left. All the ramifications lie in one plane, which intersects the primary plane in the axis of growth of the primary shoot at right angles. The ramification usually proceeds to the sixth degree. The stem grows by an apical cell, from which cylindrical segments are separated, each of these breaking up into from four to seven, usually six, peripheral and one central cell. Each of the former then divides again by a septum, the commencement of the cortical structure. The primary axis has unlimited, the lateral axes limited growth.

In *Herposiphonia tenella* and *secunda* the axes and the short shoots (Kurztrieben) grow by means of an apical cell which is repeatedly divided by septa; the number of segments is indefinite in the long, definite in the short shoots. Each segment breaks up by longitudinal divisions into peripheral cells and a central one, the number of the former sometimes amounting to as many as twelve. The lateral structures on the axes are of three kinds, root-hairs or rhizoids, lateral or long shoots, and short shoots. The rhizoids arise from the first peripheral cells of the axes, and hence on their convex side. The long and short shoots are formed from the undivided cells in strict acropetal succes-

* 'Bot. Zeit.,' xxxviii (1880) p. 161.

sion; but at first the long shoots lie considerably behind the short ones in growth. The long shoots stand on the middle line of the two flanks in regular alternation right and left. The short shoots stand on the concave side in two planes also in regular alternation right and left. Their growth closes either with an abortive apical cell or with the formation of leaves. The leaves arise from the youngest segments, and even from the apical cell itself; they usually consist of rows of cells branching in a pseudo-dichotomous manner. The leaves which are not developed from the apical cell stand on the convex side of the short shoots. There is no formation of cortex in either species.

**Fructification of Chætopteris plumosa.***—Although the peculiar fructification of the Sphacelariaceæ has been described in several recent treatises, the favourable illustration furnished by *Chætopteris plumosa* appears hitherto to have been neglected. This deficiency is now supplied by R. Wollny, who obtained his specimens from Spitzbergen and Heligoland.

This Alga usually grows on rocks and stones at a depth of from 10 to 20 metres below the surface, and is therefore very difficult to obtain in the autumn and winter months, when the formation of the reproductive organs is proceeding. The plant is also subject, in its native habitat, to a pressure of water of from one to two atmospheres; and it is questionable whether the processes that take place under the abnormal conditions of light and pressure occurring on the microscopic slide would be the natural ones. These processes appear to be completed about the end of December; there being two distinct periods at which fructification is produced, in autumn and in winter. That formed in the autumn is very scarce, and the exact function of the reproductive bodies the author was unable to determine.

In winter are produced the two kinds of sporangia characteristic of the Sphacelariaceæ, the unilocular and the multilocular.

The unilocular sporangia are produced in various positions on the fertile leaves, but are always formed out of terminal cells. They are usually spherical and of a dark brown colour, with granular contents, which in all probability escape in the form of numerous zoospores, as in *Cladostephus*.

The multilocular sporangia are formed on special fertile leaves, and are quite similar in external form to those of *Cladostephus*, as described by Pringsheim; they are of a greenish-yellow colour, and are divided into a great number of compartments.

The author suggests that the structures described by him as the autumn fructification and the unilocular sporangia are possibly due to the attacks of parasitic Chytridia, a phenomenon so well known in the Sphacelariaceæ.

**Fructification of Squamarieæ.**†—Professor Schmitz has made this a special subject of study, in the case of *Cruoriopsis cruciata*, a small Mediterranean seaweed, which forms small blood-red or black-red

* 'Hedwigia,' xix. (1880) p. 65.
† 'SB. Niederrhein. Ges. Natur- u. Heilkunde' (Bonn), Aug. 4, 1879.

patches on stones, shells, &c. The thallus is formed of a single plate of cells which increases by marginal growth. From this rise in a vertical direction simple or dichotomously branched filaments which are enclosed in jelly and enveloped in a common cuticle. The tetrasporangia are developed on certain of these vertical filaments, branches of which suspend their apical growth, the terminal cell developing into a tetrasporangium.

On the same plant are formed also the sexual organs, antheridia and "procarpia." The antheridia are formed by rapid cell-multiplication from the upper end of special filaments; the procarpia in the same way, the terminal cell of a filament developing into a long, slender trichogyne. But in addition to these, procarpia of a second kind are also formed, in the shape of short lateral 3–5-celled branches on numerous filaments of the thallus. The terminal cell of these lateral branches, which always remain imbedded in the thallus, does not develop into a trichogyne, but retains the same form as the other cells. After the trichogyne of the first kind of procarp has been fertilized, a filament springs from its base, which branches and spreads in the interior of the thallus, and there fertilizes a procarp of the second kind by placing itself in apposition to one of its cells. Some or all of the remaining cells of the procarp swell up in consequence, and develop spores. These chains of spores constitute the fructification of these Algæ, to which Zanardini has given the name "cystidia."

In other species of Squamarieæ examined, the process was the same, indicating an analogy to that which occurs in *Dudresnaya*.

**Fresh-water Algæ of Nova Zembla.***—The fresh-water Algæ collected in Nova Zembla by Dr. F. Kjellman are described by N. Wille with the assistance of Professor Wittrock. The total number of species is 172, belonging to 57 genera. Of Desmidieæ there are 100 species belonging to 13 genera; the following new forms are described and figured:—*Oocystis* (?) *Novæ Semliæ*, *Sorastrum* (?) *simplex*, *Cosmarium pseudisthmochondrum*, *subnotabile*, *Kjellmani*, and *Novæ Semliæ*, *Staurastrum Kjellmani* and *Novæ Semliæ*, and *Gonatozygon Kjellmani*. *Microspora* is united with *Conferva*, and the mode of cell-division in the latter genus minutely described.

**Thermal Anabæna.**†—In the thermal spring known as Fontaine chaude de Dax, at a temperature of 57° C., H. Serres noticed an Alga which lined the basin beneath the surface of the water, and which he regards as *Anabæna thermalis*. It originally develops as long, slender, colourless, coherent filaments, which produce small, globular organic bodies, singly or arranged in rows. The cylindrical filaments finally become moniliform and curved. The separate portions afterwards develop into branches which may be *Mastigocladus laminosus* Cohn, and which combine into a complicated network. Between the threads

* 'Öfvers. af kongl. Vetensk-Akad. Förh.' (1879), p. 13. See 'Bot. Centralbl.,' i. (1880) p. 35.

† 'Bull. Soc. de Borda à Dax,' v. (1880) p. 13. See 'Bot. Centralbl.,' i. (1880) p. 257.

filaments were also observed, which presented a resemblance to *Oscillatoria labyrinthiformis*.

**Polycystis æruginosa, a cause of the Red Colour of Drinking-water.***—In a garden-ditch in a village in West Prussia, from the month of June till the end of August, 1877, and again in 1878, the water assumed on the surface during the day a burgundy or reddish-brown colour, changing at sunset to green. This has been determined by Magnus of Berlin to be caused by a superficial growth of the Alga *Polycystis æruginosa*.

**Rain of Blood.**† — In the year 1878, J. Brun noticed on the sacred mountain Djebel-Sekra, near the sacred city of Ouessin, in Morocco, a so-called "rain of blood," which he found to result from a quantity of minute shining flakes, which adhered closely to the rocks, and presented an extraordinary resemblance to drops of blood. These were found to be a young, undeveloped condition of *Protococcus fluviatilis*, mixed with organic remains and extremely fine sand. The explanation suggested was that they were brought by a strong south-west wind from the Sahara, where the *Protococcus* is assumed to be extremely abundant.

**Endochrome of Diatomaceæ.**‡—M. Petit has compiled a very useful account of all that is at present known respecting the colouring matter of the cell-contents of the Diatomaceæ, a full translation of which is appended:—

"Hitherto, so far as I know, there has been published no general work on the endochrome of the Diatomaceæ. There is, however, no lack of papers, but they are scattered through the numerous works which have appeared in England, America, Germany, &c., during the last fifteen years. I am going to attempt to collect the data which we possess on this subject, adding some of my own personal observations. I have considered that, for clearness, it is preferable to put aside the erroneous opinions which inevitably prevailed in the early days of the study of this very interesting group of unicellular Algæ, and only to consider those which have been recognized as correct by the greatest number of observers.

1. *Nature of the Endochrome.*—Every one knows that the Diatomaceæ are distinguished from other unicellular Algæ by their envelope, which is formed of two siliceous valves which fit one in the other, and also by their colour, varying from *pale yellow to dark brown*. They owe this particular tint to a coloured plasma, which affects (in a manner invariable for every species in a healthy state), sometimes the form of *laminæ*, sometimes that of *granules*.

This coloured plasma, called by Kützing § *gonimic substance* (*substance gonimique*) is now known under the name of *endochrome*,

* 'Ber. Versamml. Westpreuss. Bot. Zool. Ver. Marienwerder.' See 'Bot. Centralbl.,' i. (1880) p. 195.

† 'Bull. Soc. Belg. Micr.,' v. (1880) p. 55.

‡ 'Brebissonia,' ii. (1879–80) p. 81.

§ 'Die Kieselschäligen Bacillarien oder Diatomeen.'

which is not applied to the coloured plasma of the Diatomaceæ alone, but also to that of all the Algæ in general, whatever their colour.

The endochrome of the Diatomaceæ does not give up its pigment either to cold or boiling water, but after rather prolonged maceration it is completely decolorized by cold alcohol, and the latter acquires a brownish-green colour of greater or less intensity.

If the plasmic masses of the frustules are examined after maceration in the alcohol, they will be found unchanged in form. They are still, as before, either laminæ or granules—they have only lost their colour. The plasma, without any sensible loss of form and without diminishing, so to say, in volume, has yielded up all its pigment to the alcohol. From this we are led to conclude that the colouring matter impregnates the plasmic masses contained in the frustules, in the same way as chlorophyll impregnates the chlorophyll-bodies in the higher plants.

It is by maceration in alcohol that the pigment is extracted from Diatomaceæ. It is first of all necessary to procure diatoms free from Oscillatoria or any other kind of alga; wash them several times in fresh water, if they are marine species, and afterwards in distilled water; let them drain for some time, and dry them rapidly between sheets of filtering paper. The diatoms thus prepared are then immersed in a volume equal to their own of 90 per cent. alcohol, and left to macerate protected from the light. As soon as the diatoms experience the contact of the alcohol they take a very distinct green colour and the alcohol immediately becomes a golden yellow.

After six or eight days the alcohol has taken a dull green colour more or less inclining to brown, and the diatoms have in a great measure lost their colour; but it is only after a month or more of maceration that the plasma becomes completely colourless. Filtered after eight days of maceration we obtain a concentrated alcoholic solution of the pigment.

2. *Historical.*—M. Nägeli * was one of the first to mention the colouring principle of the Diatomaceæ and describe its chemical properties. He considered this colouring matter to be simple, and gave it the name of *diatomine*, which we will preserve, because of its analogy to chlorophyll, which is itself a compound body.

However, before him, M. de Brebisson † first, and later on Kützing,‡ had remarked that "*Melosira* becomes green when dried upon paper." Kützing had moreover proved that the brown colouring principle becomes green under the influence of hydrochloric acid, and that alcohol removes from the plants a green pigment resembling chlorophyll.

In 1867 M. Askenasy § had succeeded in isolating, in an imperfect manner, it is true, the two colouring principles of diatomin, and had recognized their principal chemical and optical properties. Although these experiments were not at the time considered as conclusive, they

* 'Gattungen einzell. Algen,' p. 7.

† Brebisson and Godez, 'Algues des Environs de Falaise,' 1835, p. 11.

‡ 'Bacillarien,' p. 23.

§ "Beit. z. Kennt. der Chlorophylls-Farbstoffe," 'Bot. Zeit.,' July, 1867.

have nevertheless been confirmed by the spectroscopic observations of M. Nebelung in his study of the colouring matters of some fresh-water Algæ.*

It was reserved for MM. Kraus and Millardet † to make known the true nature of the pigment of the Diatomaceæ. They succeeded, by means of benzine, in separating from the alcoholic solution of diatomine two colouring principles; one giving a fine golden yellow solution and possessing all the properties of *phycoxanthine*, discovered by the same authors in the Algæ of another group; the other giving a green solution having properties identical with those of chlorophyll. Kraus and Millardet drew this conclusion from their observations, that *diatomine is formed of a mixture of chlorophyll and phycoxanthine.*

When an alcoholic solution of diatomine is filtered, a fact very simple in itself gives a proof of the presence of two colouring principles. If the filtering paper used is allowed to dry, we see a broad coloured border formed round the margin; the outer part being tinted yellow while the inner is green.

To conclude the historical part I will cite the direct spectrum analysis made in 1869 by Professor H. L. Smith of New York,‡ by means of the microspectroscope. The spectrum obtained with the small portion of endochrome from a single diatom, a *Navicula*, showed the absorption-band in the red and complete absorption of the second part of the spectrum, without intermediate bands. This spectrum would seem to correspond with that of phycoxanthine. (Fig. 54, No. 2.)

(3) *Diatomine.*—Let us now see what are the physical properties of diatomine and of each of the elements of which it is composed.

A concentrated solution of diatomine, prepared according to the process indicated above, has a green colour verging on brown if examined by transmitted light. This colour may be more or less deep. We shall see further on to what cause must be attributed this variation in the tint. By reflection the same solution has a carmine red fluorescence nearly resembling that of chlorophyll.

Concentrated sulphuric and hydrochloric acids give to the solution of diatomine a tint of an intense bluish-green, and different from that which the solution of chlorophyll takes with the same reagents.

Ammonia gives no apparent reactions. Lime-water, and especially baryta-water, render the solution of diatomine turbid, without producing any precipitate similar to that obtained with the solution of chlorophyll.§

If a concentrated solution of diatomine is examined by the spectro-

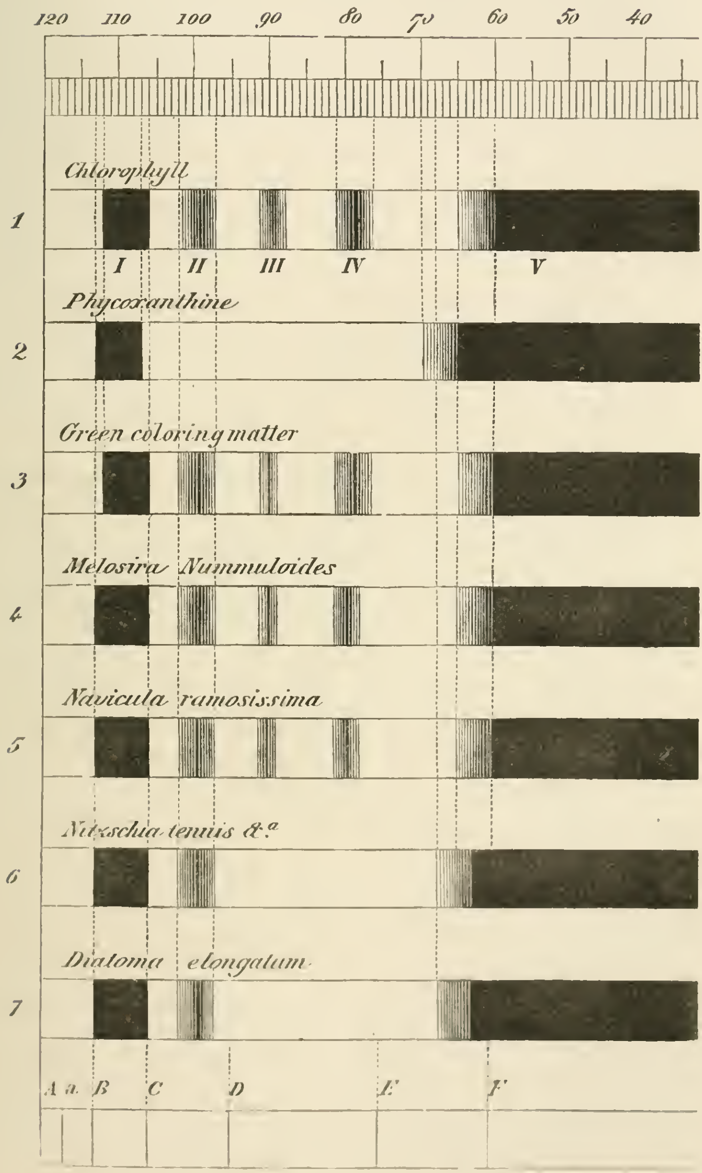
* "Spectrosk. Untersuch. des Farbstof. einig. Süsswasser-Algen," 'Bot. Zeit.,' June 21, 1878, pp. 394–395.

† "Études sur la matière colorante des phycochromacées et des diatomées." (Extract from 'Mém. Soc. Nat. Sci. Strasbourg,' vi. 1868.)

‡ 'Silliman's Journal,' vol. xxxviii. (1869) p. 83.

§ See for further details Ad. Weiss, 'Zum Bau und der Natur der Diatomaceen,' p. 115.

FIG. 54.


120
110
100
90
80
70
60
50
40
Chlorophyll
1
I
II
III
IV
V
Phycoxanthine
2
Green coloring matter
3
Melosira Nummuloides
4
Navicula ramosissima
5
Nitzschia tenuis &.a
6
Diatoma elongatum
7
A a. B
C
D
E
F

scope, it will be seen that its spectrum closely approaches that of chlorophyll (Nos. 1, 3, 4, 5). Through a layer of two centimetres' thickness a wide black band can be seen (I., Nos. 3–5), with well-defined edges, in the red from 107 to 112 between the B. and C Fraunhöfer lines, and three small bands less marked and softened off at the edges, one (II.) in the orange between C and D, from 97 to 102, another appearing *very faintly* (III.) near the yellow from 89 to 91, and finally one in the green (IV.) on the left of E, from 78 to 81. The second part of the spectrum is completely absorbed as far as F, that is, to the limit of the blue and green.

The sensible difference between the spectrum of diatomine and that of chlorophyll relates to band I.; with diatomine the red band is withdrawn as far as 113, whilst with chlorophyll this band stops at 111·5.

A very thick layer of the solution allows nothing to pass but the rays of the extreme red, and a few of the yellow ones near to D.

The spectrum which I have just described is that which is most frequently met with; but it may happen that the bands III. and IV. are not seen in the spectrum, although bands I. and II. are clearly marked. These differences result, as will be seen, in a variation in the composition of diatomine.

(4) *Separation of the two Colouring Principles.*—To separate the two colouring principles which compose diatomine, Kraus and Millardet employ the following process * :—Some diatoms are macerated in alcohol, as has been mentioned above. "After some days, when the alcohol is well saturated, the solution is filtered, and into it is poured from two to three times its bulk of pure benzine. It is necessary to use 36 per cent. alcohol, as in this case the two liquids do not mix, as would happen if absolute alcohol were used. The whole is put into a flask, and strongly shaken for a minute or two, and then allowed to settle. The yellow colouring principle, being more soluble in the alcohol than the green, remains dissolved in it, whilst the benzine takes up the green. After decanting, the alcoholic solution is treated with a fresh quantity of benzine, again shaken, allowed to settle, and decanted; this operation is repeated until the benzine ceases to be coloured green." To isolate the two colouring principles it is sufficient to evaporate the solutions.

The process of Kraus and Millardet has the inconvenience of requiring a great deal of time, for which reason I prefer to employ the following process, which leads more rapidly to the same result.

I take a solution of diatomine, prepared with 90 per cent. alcohol, and I dilute it with an equal volume of distilled water to diminish the strength of the alcohol; the solution does not become turbid. To this mixture I add chloroform in quantity equal to one-third of the total volume. After shaking it for a minute or two I leave it to settle. In a few hours the separation is complete; the chloroform takes up the green colouring principle, and sinks to the bottom of the flask, whilst the yellow, which is more soluble in weak alcohol, remains in the superficial part. After decanting, I again wash with

* Loc. cit., p. 26.

chloroform in the same way as before. Usually this second washing suffices to remove all that remains of the green colouring principle. If the supernatant portion is turbid its transparency will be restored by pouring into it a small quantity of 90 per cent. alcohol. We then have the two colouring principles separately, and it suffices to evaporate the solutions to obtain the principles in a solid state.

*Green Colouring Matter—Chlorophyll.*—The solution of the green colouring matter possesses a fluorescence of a wine-red colour; by transmitted light it has an emerald green tint, but this tint may be more or less deep. The properties of this colouring matter show a very great analogy with those of chlorophyll. Its spectrum (Fig. 54, No. 3) is altogether similar to that of chlorophyll (No. 1); the band III. above is less marked. We may therefore conclude with Kraus and Millardet (*loc. cit.*) that the green colouring matter extracted from diatomine, either by benzine or by chloroform, is no other than the chlorophyll of the higher plants.

A proof of this opinion may be found by collecting the gas which escapes during the respiration of diatoms exposed to the light. It is easy to prove that this gas is oxygen, which evidently arises from the decomposition of the carbonic acid by the chlorophyll under the action of light.

*Yellow Colouring Matter Phycoxanthine.*—The alcoholic solution of yellow colouring matter has a brick-red fluorescence, less intense than that of diatomine. By transmitted light it shows a fine golden yellow tint, which disappears after a short time even in diffused light. If this solution is diluted with twice its bulk of distilled water it neither precipitates nor becomes turbid.

Concentrated sulphuric and hydrochloric acids communicate to this solution a *greenish-blue* tint, exactly similar to that of certain Oscillatorieæ.

If we examine by the spectroscope a solution of yellow colouring principle, concentrated and completely freed from chlorophyll, we find (Fig. 54, No. 2) a very black band in the red from 108 to 113, and the second part of the spectrum is absorbed as far as the middle of the green at 65, decreasing as far as 70. The band I. is displaced towards the extremity of the red, and does not agree with that of chlorophyll.

All the physical and optical properties just cited show that there exists a great analogy between the phycoxanthine of Kraus and Millardet and the yellow colouring matter of diatomine; therefore I do not hesitate to consider them identical, as do these two authors.*

Kraus and Millardet have proved the scarcely perceptible presence of band II. in the spectrum of phycoxanthine; the cause of this result must be attributed to the process employed by these two observers, the benzine not succeeding in eliminating the last traces of chlorophyll.

M. Nebelung,† in using the same process to separate the two colouring principles, was also able to see with great difficulty band II.

* Loc. cit., p. 32. † Loc. cit., p. 396.

I have never succeeded in seeing this second band, even with a very thick layer of solution diluted with chloroform.

(5) *Relation between the two Colouring Principles.*—We will now consider to what cause is due the more or less deep tint of the different species of Diatomaceæ.

Chance having aided me in my researches, I have succeeded in gathering pure species, and comparing *inter se* the results obtained. I found first, in March 1878, very pure *Diatoma elongatum* in the ditches of the forest of Bondy; secondly, in May, *Nitzschia tenuis* and *linearis*, with some *N. sigmoidea* in the watercress-beds of Mitry; thirdly, in September, my friend Dr. Leuduger Fortmorel brought me from Saint-Brieuc a large collection of very pure *Melosira nummuloides;* and fourthly, I was able to collect in June 1879 a large and very pure quantity of *Navicula* (*Schizonema*) *ramosissima* on the rocks of Dieppe, where, at low water, the fronds can be removed one by one.

It is the spectra obtained with the solutions of diatomine resulting from these various gatherings that are represented in Fig. 54, Nos. 4, 5, 6, 7.

When the colouring principles are separated by means of chloroform it is seen that the chloroform assumes a dark green colour with the solutions furnished by *Melosira* and *Navicula*, whilst it only acquires a pale green tint with the solutions from *Nitzschia* and *Diatoma elongatum.* The spectra of the solutions furnished by *Melosira* and *Navicula* show the four bands of chlorophyll, whilst the solutions from the two other species only show bands I. and II. The first two species, therefore, contain more chlorophyll than the two others, and as they have a browner tint it must also be concluded that this dark tint is caused by the abundance of the chlorophyll.

This observation clearly shows that the plasma of Diatomaceæ has not an equal capacity for chlorophyll, whilst their capacity is nearly the same for phycoxanthine. Thus the relations between the two colouring principles may vary enormously from one species to another. This fact also confirms the opinion of M. Borscow,* that the variation of colour in the different species is due to the excess of one of the two pigments over the other.

Certain diatoms often take a pale green tint without any evident cause (*Navicula viridis*, *Fragilaria virescens*). I incline to the opinion of M. Borscow, who attributes this colour to the almost entire disappearance of phycoxanthine under the action of a cause still unknown.

The colour of the Diatomaceæ varies sometimes in a sensible manner, and especially it becomes darker towards the time of the act of division, afterwards resuming its normal tint.

It would seem, therefore, that the proportion of chlorophyll increases in the plasma at the epoch at which it attains its maximum of vital force. The plasma assumes a still deeper tint shortly before the formation of the auxospores, but resumes its natural tint as soon as the silicification of the cell is about to begin, as I have succeeded in

* 'Die süsswas. Diatomaceen des Süd-Westlichens Russlands,' p. 67, note 15.

proving in the specimens gathered in the pond of Saint-Cucufa in February 1877.

Besides these transient changes, the plasma usually preserves a colour of its own. Thus, *Navicula* in general, *Melosira*, *Pleurosigma balticum*, *Rhabdonema*, &c., present a very dark brown colour, whilst *Cocconeis*, *Nitzschia*, *Diatoma elongatum*, *Amphiprora alata*, &c., only show endochrome of a very pale yellowish-brown.

If we examine the spectra furnished by the different solutions of diatomine we shall see that the bands I. to IV. of chlorophyll appear when the latter exists in larger quantity than the phycoxanthine. On the other hand, the bands I. and II. only are seen, and not bands III. and IV., when the chlorophyll exists only in small quantity. In the latter case it is the spectrum of phycoxanthine which dominates, because the absorption of the second part of the spectrum extends to 63 and decreases to 68.

(6) *Conclusions.*—It will be readily understood from the preceding that certain Diatomaceæ, particularly the darkest, *Melosira*, *Navicula*, &c., may become green by desiccation. In this case the phycoxanthine, which is very unstable in the light, disappears first, whilst the chlorophyll persists much longer.

The green tint which the Diatomaceæ take under the action of acids is communicated to them by phycoxanthine, which turns green when in contact with acids.

The action of alcohol, and consequently that of glycerine, may be explained by the often observed fact that phycoxanthine, being more soluble in alcohol than chlorophyll, is separated from the latter, which remains longer inside the frustules without dissolving. Perhaps also the alcohol effects a simple molecular change in diatomine, and separates, by isolating them, the yellow and green colouring principles, which were intimately mingled.

To sum up: the endochrome of the Diatomaceæ contains a colouring substance, *diatomine*, which has much analogy with the chlorophyll of the higher plants. This colouring principle splits up into phycoxanthine and chlorophyll; but the proportions of these two colouring substances varies in different species. The Diatomaceæ which are the darkest in colour are those which contain the most chlorophyll. Finally, the spectrum of diatomine shows a great analogy to that of normal chlorophyll."

**Belgian Diatomaceæ.** — Dr. H. van Heurck, of the Botanic Garden of Antwerp, has published, with the aid of Herr A. Grunow, the 1st part of a Synopsis of the Diatomaceæ of Belgium, which will consist of 6 parts, with heliographic plates. (Parts 1 and 2, Raphideæ; Parts 3 and 4, Pseudo-Raphideæ; Parts 5 and 6, Crypto-Raphideæ.) The author points out the favourable situation of Belgium as regards these Algæ: the North Sea coast furnishing nearly all the marine species described by English observers; the Ardennes, a good number of the European Alpine species, and the central parts of Belgium, the fresh-water species forming the foundation of the European flora.

In his preface the author says that all the drawings have been made with the greatest exactness, and by means of the most perfect objectives. They were drawn by himself or under his eye, and retouched by himself or Herr Grunow, who has also drawn the plates of some of the groups. The power used was one of 900 diameters for the easier forms, and 1500 for the most difficult, and the drawings were then reduced one-third by heliography. Owing to the care that has been taken, the excellence of the objectives, and the use of heliography, he thinks there can be no doubt as to the species figured. "Unhappily one cannot say as much for the greater part of the drawings of diatoms published during the last fifty years, a great part of which are enigmas more or less insoluble even with the aid of authentic specimens."

Dr. Van Heurck's botanical museum contains the original types of the principal diatomographs—Kützing, Walker-Arnott, Eulenstein, De Brebisson, &c.

**New Deposit of Diatomaceous Earth.**—At the May meeting of the San Francisco Microscopical Society, the President announced, that more of the celebrated Santa Monica diatomaceous earth, or some similar to it, had been discovered. The deposit is about seventy miles from the spot where the original piece was first discovered by Mr. T. P. Woodward, two years ago. The present theory is that the former piece became detached from the main deposit, was washed into the sea, and then carried by the tide to the shore on which it was found. Professor H. L. Smith, of Geneva, N.Y., reported by a letter read by the President that he had tried the deposit and found it so rich and so nearly like the "Santa Monica," that he desired a quantity. Mr. Norris and ex-President Hyde had also made a careful examination of the material, and the former presented a mounted slide which showed forms of great beauty and fully as rich as the original of two years ago.

It is added that "scientists all over the world, it is to be hoped, can now be supplied with this very interesting material, for which they have been so anxious."

**Preservation of Solutions of Palmelline.***—Dr. T. L. Phipson says that the solution of palmelline obtained by allowing cold water to stand for a day or two over the air-dried plant (*Palmella cruenta*), as described by him,† like all solutions of albuminoid substances, is very subject to decomposition, and at temperatures of 75°–80° F. putrefaction sets in rapidly. The beautiful rose and yellow dichroic tint of the solution becomes paler, and finally disappears, whilst the liquid takes a strong ammoniacal odour and swarms with *Bacterium*, *Vibrio*, and *Spirillum*. The latter are not easily to be distinguished (except by their small size and that their motion is more rapid) from the *Spirillum* which is present in the blood in cases of relapsing fever, during the pyrexia only, disappearing as the temperature of the body falls.

Various methods of preserving the liquid in question without altering its composition and optical properties were tried. Exclusion from air and light were only partially successful for short periods.

* 'Chem. News,' xli. (1880) p. 216. † See this Journal, *ante*, p. 319.

The addition of a little salicylic acid modifies the delicate purple-rose tint and destroys the dichroism, so that the orange-yellow is no longer seen by reflection; moreover, it only preserves the liquid for a week or two, after which the phenomena alluded to set in as above described. Finally it was found that ether, which has no solvent action on palmelline and does not affect its composition nor coagulate it, may be used with success to preserve the liquid for an indefinite period. It is sufficient to add a small quantity of ether to the solution in a tube, cork it, and turn it over once or twice so as to dissolve as much ether as possible in the liquid, to preserve it with all its properties for several months. As long as the contents of the tube have a strong odour of ether no decomposition sets in, and the optical properties of the palmelline remain intact.

This simple method of preservation may be found applicable to many other organic substances upon which ether exerts no chemical action.

## MICROSCOPY, &c.

**Localities for Fresh-water Microscopical Organisms.** — In the recent discussions on the proposed purchase of the works of the Metropolitan water companies, the case of Birmingham, where they were acquired by the Corporation authorities, has been referred to. London microscopists would have good reason to rejoice if the result that has been obtained in Birmingham were repeated here, so that an abundant supply of rare and interesting species of Rotifers, Infusoria, &c., should be brought to, or rather within, every microscopist's doors, without the drawbacks of pond-hunting. In Birmingham the ordinary supply of water for drinking and other purposes, received through the pipes, has just been found to contain the rare Rotifer *Anuræa longispina*, first found last year by Professor Kellicott of Buffalo, U.S.A.;* also *A. stipitata*, *Triarthra longiseta*, *Salpina redunca*, *Dinocharis pocillum*, and some Tardigrada.

Of other forms, the latest addition to fresh-water life is *Ceratium longicorne*, very plentiful, but few living, though its congener *Peridinium tabulatum* seemed none the worse for its temporary sojourn in the pipes. Large quantities of the curious compound organism, *Dinobryon sertularia*, are also to be noted. The Vorticellidæ and Entomostraca are represented, the former by both branched and simple forms, and the latter principally by *Bosmina longirostris*, with his two long and curved antennæ, evidently much the worse for his compulsory visit to town, either the distance travelled or the mode of transit being unsuited to his well-being.

Diatoms are mostly present in the stellate species, *Asterionella formosa*, with a few specimens of *Synedra* and *Pleurosigma*, while Desmids are fairly plentiful in *Pediastrum granulatum* and *Hyalotheca*; also *Pandorina morum*, *Clathrocystis*, and other algæ.

Mr. J. Levick, from whose paper † the above list of organisms is taken, suggests that their presence should rather be considered as

* See this Journal, ii. (1879) p. 157. † 'Midl. Nat.,' iii. (1880) p. 166.

indicative of the general good quality of the water than otherwise, as some of them, at least, are known at home and abroad as the inhabitants of deep, clean water only.

It is curious that hitherto neither *Leptodora hyalina* nor *Hyalodaphnia Kalbergensis* have been found by London microscopists, and yet it cannot be doubted that it must be as plentiful in the neighbourhood of London as of Birmingham. For the former a deep reservoir seems to be essential, the net being dipped 6 or 7 feet.

**Collection of Living Foraminifera.***—Having been occupied for some years in the study of the rhizopodous fauna of the coasts of France, M. Vanden Broeck thinks it may be useful to those similarly occupied to publish instructions with a view of facilitating the collection of Foraminifera. The original instructions are very concise and they necessarily suffer in the further condensation which we have been obliged to give them.

In general, the coarse and purely quartzose sand is very poor in Foraminifera, though under certain favourable conditions interesting results may be obtained, when for instance it contains a sufficient quantity of the débris of shells, sponges, algæ, &c.

The tide often washes up on the shores of an indented coast a kind of littoral band, at high-water mark, consisting of algæ and light débris of shells, sponges, &c., which generally furnishes good material for the collection of Foraminifera. The débris, if it contains many algæ, should be washed in an abundance of water, lightly rubbing it between the hands. To preserve the Foraminifera alive, salt water must be used; fresh, if the shells only are desired, the latter preventing the saline efflorescences which would otherwise cover the shells. The floating residue must be thrown away, carefully preserving the sand deposited in the vessel. Precautions must be taken not to throw away the Foraminifera, which, being lighter than the grains of quartz, float above the sand, under (not on the surface of) the water. The water can also be filtered through coarse muslin and the residue of algæ, &c., rejected.

The algæ gathered on the beach, or better still, taken from the place of their growth, give equally good results. It is useful to preserve unwashed a few roots of algæ and flexible polyps, as a great number of living Foraminifera are attached to the leaves and false roots.

We sometimes find on the coast, amongst the shells and Foraminifera of recent fauna, others coming from fossil beds, tertiary, cretaceous or otherwise, which, bordering on the sea, are worn away by the action of the waves, or crumble into it from the cliffs which are undermined at high tide. Thus fossil Foraminifera become dispersed among the recent fauna, and it is therefore very important to take into consideration the neighbourhood in which the sand has been collected.

In the coarse sand and residues of the shore we generally find nothing but rolled and worn Foraminifera belonging exclusively to

* 'Journ. de Microgr.,' iii. (1879) p. 237.

the large, thick-shelled species; those with fragile and delicate shells, that is to say the most numerous and beautiful, can only live and develop properly on muddy bottoms, or where the sand is fine and somewhat slimy, and it is necessary therefore to investigate such deposits also. For this purpose, some of the following indications may be followed according to the locality.

Collect at low water (either with the hand or a small dredge) the superficial portion of the mud or slimy sand found in ports or the mouths of rivers, or higher up in their course if the water is salt. The glutinous coating, generally green or brownish, which covers the mud or slimy sand in quiet places often gives excellent results. The thick black mud beneath is less rich in Foraminifera than the upper portions.

It is also useful to explore the large pools which remain at low water, either on the shore when the sand is not too coarse, or in the estuaries, or even the cavities often met with among the rocks or at the foot of cliffs. It must be remembered that the most favourable spots are always those which are covered with very fine or slimy sand. Sediments which are coarser but rich in fine débris, are also favourable.

Whitish zones are sometimes seen on the margins of pools left at low tide, composed of little heaps accumulated in the numberless ridges produced in the sand by the retreating water. These whitish heaps consist of small organic débris, spiculæ of sponges, spines of echinoderms, fragments of shells, &c., often mixed with a quantity of Foraminifera, of which a great many can be collected by a spoon.

By means of a simple magnifier the presence of living Foraminifera can be established on the spot. If, for example, some of the deposit is examined in a shallow vessel (such as the cover of a tin box) and under a small quantity of water, the Foraminifera will be readily recognized as small coloured points of red, rose, or yellow—tints which are given to the thin shell of many species by the colour of the sarcode within.

The places where the water is relatively quiet are the only really favourable ones for finding Foraminifera. Dredgings from a depth of from 8 to 10 metres (when the water at the bottom is little moved, however rough it may be on the surface), always give good results, unless the bottom consists of purely quartz deposit or gravel, as is the case in regions subjected to rapid submarine currents, as in the Straits of Dover. The interest of the collections increases in proportion to the depth at which they have been made.

For the benefit of those who have not dredges at their command, it may be mentioned that the mud brought on board by the anchors of ships, or the detritus on the nets of fishermen, furnish species which are not found on the coast.

Foraminifera may also be found in the contents of the stomachs of fishes, molluscs, crustacea, actiniæ, medusæ, salpæ, &c.

Certain species of Annelida, *Terebellæ* for instance, form a protecting sheath which often contains Foraminifera not found on the shore.

The sand and slime of salt marshes in periodical communication with the ocean furnish species which almost exclusively inhabit brackish water, and others which present special characters.

In the same way as the cases constructed by the larvæ of the Phryganeidæ give in fresh water a rich harvest of small shells and Entomostraca, so also in brackish water they contain Entomostraca and Foraminifera often of rare and interesting species.

Oyster and mussel beds are also favourable spots, but in examining Foraminifera from artificial oyster-beds it must be taken into consideration whether the oysters are of French, English, American or other origin, as Foraminifera foreign to the region may be found which were originally brought there with the oyster shell.

In a given locality many variations are found in the faunal elements, according to the time of collection; it is advisable, therefore, to collect at different seasons, and during two or three consecutive years, if the fauna is to be thoroughly studied. Changes of temperature are caused by currents, especially deep currents, which thus influence the fauna of the bottoms over which they pass as well as by the foreign matter which they bring. It will be useful therefore to find out whether they are hot or cold, periodical or continuous, and to know their origin and direction.

In conclusion, the author points out that his instructions apply equally to the Entomostraca which generally accompany Foraminifera in their different habitats.

**Cleaning Foraminifera.***—After having read Mr. Vorce's article on cleaning Foraminifera,† it occurred to Mr. K. M. Cunningham to use electrical force to extract the shells in the dry way. For this purpose he used a small tin lid, 4 inches in diameter, filled with a preparation of rosin and sealing-wax, the resinous surface of which, for convenience, he excited with an artist's brush, known as a "badger blender." The sand from sponges or foraminiferous marl is spread thinly over as large a surface as convenient; the cake of rosin is then excited by passing the badger's-hair brush over it several times, and then turning the excited surface of the resinous cake down to within a quarter of an inch of the material, and passing it gently over it. The result will be that innumerable light particles will be attracted to the excited surface, and will remain there, while the sand will be attracted and repelled, thereby leaving a large percentage of Foraminifera, spicules, &c., adhering to its surface, which may then be brushed off into any suitable receptacle. The above plan may be tested on a small scale by exciting the end of a large stick of sealing-wax. Damp weather is unfavourable for the experiment.

**Wax Cells.‡**—Referring to Dr. Hamlin's note on this subject,§ it is suggested (1) that before applying pressure to the outer edge of the disk a little turpentine should be applied to the lower surface with a brush extending to the proposed width of the ring, and (2) that instead of a *slight* moistening of the knife-blade, water should be used *freely*.

* 'Am. M. Micr. Journ.,' i. (1880) p. 88. † *Ante*, p. 497.
‡ 'Am. M. Micr. Journ.,' i. (1880) p. 98. § *Ante*, p. 507.

**Carbolic Acid for Mounting.***—Mr. F. Barnard, of Kew, Victoria, writes that some years ago he mentioned the use of carbolic acid (the best crystallized with just sufficient water to keep it fluid) in mounting microscopical objects, and is led to believe that the subject is comparatively unknown in England, though in use in Victoria more than ten years, and to such an extent that turpentine is seldom used in many studios. The first specimen he saw it tried upon was the head and jaws of a spider mounted by Mr. Ralph, the President of the Microscopical Society of Victoria, which led Mr. Barnard to try it in various ways to render objects transparent, and now he seldom uses anything else. Whether it is animal or vegetable tissue the effect will be the same, the acid will in a very short time render the object transparent, and the Canada balsam will when applied run in as readily after it as turpentine.

In the case of such an object as a palate of a mollusc, wash it well in water and remove it to a bottle of the acid for a few hours, or if it is desired to mount it at once, place it after washing on a glass slip in proper position for mounting and drop one or two drops of the acid on it. At first it will look thick and cloudy; warm the slide over the spirit lamp, let it cool, and drain off the acid; if not perfectly clear when cold, apply some fresh acid and warm again; place on a cover if not previously done, and apply the balsam, by means of a little heat it will run under. With polyzoa the easiest plan is to place them in a little hot water which softens them, then lay them out on a glass slip; place another on it which is of sufficient weight to keep them in position while they dry, then drop them into a bottle of carbolic acid and soak for a time; twenty-four hours will render any polyzoa transparent without rendering them brittle, and the author says he has mounted specimens perfectly clear and transparent in ten minutes from the time they were alive in the zoophyte trough, treating them as above recommended for palates. For gizzards and parts of insects he also considers that nothing comes near it.

One great advantage carbolic acid has over turpentine is that it never renders specimens brittle. They can be pulled about as readily as when fresh. Should there ever be any clouding, it arises from the moisture of the object, not from the carbolic acid, but from want of it. It is comparatively inexpensive, far less unpleasant in smell, and not so sticky and dirty in use as turpentine. It is not necessary to let the object dry, which invariably alters the shape more or less; still, should it be dry it is not any time becoming transparent compared with the old process of soaking in turpentine. We all know how difficult it is to render Foraminifera transparent and free from air ready for mounting in balsam. One trial of carbolic acid will convince the most sceptical of the advantages it has over turpentine, benzine, &c. The only drawback to its use is that it often renders some vegetable tissues too transparent.

**Double-staining of Vegetable Tissues.**†—In this paper the writer (who only gives an initial) says that, having used a number of dyes in

* 'Sci.-Gossip,' 1880, p. 137. † 'Am. M. Micr. Journ.,' i. (1880) p. 81.

double-staining vegetable tissues, the conclusion he has arrived at is, that no rules can be given which will ensure success in every case. The process is familiar to every working microscopist, but the limited number who have fairly succeeded in differentiating the tissues is somewhat surprising. In his own experience he has met with some sections which obstinately refused to act as they should under the operation of the two colours, but even these, with patient manipulation, can be induced to show some results, even though they may not exhibit that sharpness and purity which it is the aim and object of the mounter to obtain.

A writer in 'Science-Gossip' has come nearer to the true laws governing the process than any one who has written on the subject; he has at least indicated the direction in which the practical worker must look to attain success. The theory of the present author is slightly different, and consequently his process varies somewhat, but in the main it is the same. The capacity for staining tissue resides more in the colours than in the tissue itself. A stain may be permanent, unless it is driven out. It may be driven out by some solvent, by some bleaching process, or lastly by some other colour. Some tissues hold the stain more tenaciously than others, probably on account of their varying density. Thus the spiral and bass-cells will retain a colour longer under the influence of a solvent than the softer and more open parenchymal cells. He endeavours to take advantage of this property by giving the whole tissue all of one colour that it can be induced to take, and then driving it out of the parenchymal tissue by a stronger colour, stopping the process at the moment when the second colour has completely replaced the first colour in the soft tissues, and before it has begun to act upon the more dense cells. If a section be stained with roseine and then be left long enough in a solution of Nicholson's blue, the whole section will be blue, with no visible trace of red. If it be taken out before the blue has permeated the entire tissue, the red will show, in some parts, quite clear and well-defined among the surrounding blue tissues. Following out this principle, that exact point must be determined when the blue has gone far enough.

In practice the theory is carried out as follows: A two-grain neutral solution of eosin is used, and in this the prepared sections are preserved until the operator is ready to use them. They keep perfectly well in this solution, and are always ready to undergo the final process, which requires but a very short time before they can be placed, fully finished, under the covering glass. After taking them from the eosin solution, they should be passed through 95 per cent. alcohol, merely to wash off the superfluous colour, and then placed in a half-grain solution of Nicholson's blue made neutral. The time required in the blue solution varies with different tissues, and in the nice adjustment of this time lies the whole success of the operation. Three or four sections of each kind are generally spoilt in determining the exact time required. A section is taken from the eosin, holding it lightly in a pair of forceps, rinsed off rapidly in alcohol, and then immersed in the blue, still in the forceps, while ten can be counted with moderate haste. Then quickly place it in clean alcohol, and brush lightly with a camel's-hair brush. This immersion in clean alcohol seems to check the operation of the blue instantly. It should then be examined under a 1-inch objective to determine whether the exact point where the blue and the red remain distinct has been reached. If the blue has not occupied all the softer cells, another section should be taken and put through the same process, counting twelve, and so on, until the proper point is reached; or, on the other hand, decreasing the count if the blue has infringed upon the red in the more dense tissue. Having thus determined the count for the sections of that particular material, the remainder of the sections are passed through the blue into the alcohol, merely counting off the immersion of each section. Then place the sections for a few moments in absolute alcohol, which seems to fix the colours, then through oil of cloves into benzole, and mount in dammar and benzole. It is sometimes advisable, with delicate tissues, to merely rinse off the blue in 95 per cent. alcohol, and fix the colours at once in absolute alcohol, but every operator will learn the minor details for himself in the manipulation.

Of course, with the "rule of thumb" method of counting off the time slight variations will occur which will mar the beauty of the finished product; besides which minute differences in the thickness of the section will affect the result, and even a distance of a quarter of an inch in the same stem will make a difference in the density of the tissue, which will be obvious in the sharpness of the colours under the objective, so that the operator should not be disappointed if out of a dozen slides only four should be worth preserving. The others can go into the borax-pot to be cleaned for another operation. The beauty of those which do pass inspection will amply repay for the labour on the spoiled ones.

The writer says that he has perhaps been needlessly minute in the description of the process he has employed, but he has been so often hampered by the lack of minuteness in descriptions of processes by others, which he has been endeavouring to carry out, that he deems it better to err upon the safe side, even at the risk of being considered dry or prosy.

A note is added as to the use of eosin. He was attracted to it by its exquisite purity of colour under transmitted light, and its perfect transparency. Sections preserved in its solution were found always to retain their transparency, and did not become clogged or thick with colour, so that when taken out after months of immersion the most dense cells were no deeper in colour than the solution itself. So far as regards its hold upon the tissues, it is as strong as roseine, or any of the heavier colours. He cannot testify as to its permanence, but has some slides that were prepared over a year ago, and appear to be as bright and pure as when they were mounted. Contrary to the experience of some others, he has not found that the benzole has any bleaching effect, and it has been used with dammar in preference to the usual balsam. Slides prepared with dammar, however, should have a thick ring of varnish run around them, as the dammar is brittle, and should not be trusted alone to hold the covering glass.

**Wickersheimer's Preservative Fluid and Vegetable Objects.***—Dr. K. Prantl describes the results of his experiments with this fluid,† which, though so valuable for animal substances, he judged beforehand would not be applicable to parts of plants. The density of the fluid removes the turgidity of the cells without hardening the protoplasm quickly; hence the delicate parts of the plant lose their firmness, and consequently their relative position, even in the fluid. The flowers of *Tropæolum*, for example, collapsed after being a few hours in the fluid, and became unrecognizable. The lamellæ in the pileus of different *Agarici* were greatly distorted, not only after being taken out of the fluid, but whilst still in it. Those parts of a plant which possess sufficient consistency alone preserve their shape, as Ferns rich in sclerenchyma (*Blechnum australe*), and the leaves of Coniferæ, objects which can be preserved as well dry. If pine branches, however, are laid in the fluid, the falling off of the acicular leaves in drying is prevented, but this can be done just as well by concentrated glycerine.

Further, the fluid kills the protoplasm, hence the colouring matter held in solution by the cell-sap comes out in a short time. Chlorophyll has hitherto been retained, but changed into a brownish tint.

**Hardening Canada Balsam in Microscopic Preparations by Hot Steam.**‡—The inconvenience arising from the slowness with which Canada balsam hardens, especially in summer, has been felt by all engaged in making permanent preparations. M. Passauer describes a small and simple apparatus which he made for the purpose of overcoming this objection. It consists of a round vessel of tin, about 18 cm. in diameter and 6 cm. deep, with a tin cover 19½ cm. square (for convenience in placing the slides), to the under surface of which a circular rim about 1½ cm. deep is soldered and made to fit easily into the vessel. On the upper side the cover is also furnished with a rim about 5 mm. deep. In one corner of the lid, but inside the lower circular rim, a tube 6 cm. in diameter and 10 cm. long is soldered and passes through the lid.

In using it the vessel is half filled with boiling water, covered with the lid, and the preparation to be hardened laid on the latter, and the temperature of the water kept at boiling-point by a lamp placed under the vessel. Special care must be taken that the steam does not become too hot, otherwise bubbles would be produced in the balsam and the preparation be spoilt, hence the small chimney is provided, through which part of the steam can escape. By this means the balsam can be hardened in 1 to 1½ hours.

**Ringing and Finishing Slides.**§—The following article by Dr. C. Seiler gives some useful hints:—"A great deal may be said in favour of and against the careful finishing of microscopical slides, but nobody will deny that a nicely-ringed preparation looks better in a cabinet,

* 'Bot. Centralbl.,' i. (1880) p. 26. † *Ante*, p. 325.
‡ 'Zeitschr. f. Mikr.,' ii. (1880) p. 194.
§ 'Am. Journ. Micr.,' v. (1880) p. 94.

and is better taken care of by its owner and his friends, than one which is not thus embellished, and which shows a greater or less amount of balsam irregularly distributed around the edge of the cover. I will, therefore, jot down a few remarks on the ringing and finishing of slides. After the object has been mounted in balsam and the cover applied, it will be found that there is always a greater or a less surplus of balsam which comes out from under the cover. This should be allowed to dry, and when thoroughly hard it can be scraped off with a knife. If a round cover has been used, the slide is then centered on a turntable, and the cover cleaned with benzole, which is best done by dipping a soft linen rag in the benzole and applying the wet place with the forefinger to the centre of the cover-glass; the turntable being revolved, the finger is quickly drawn toward the edge of the cover and the rag removed. One or two such wipings of the cover will be found sufficient to remove all traces of balsam or extraneous dirt. The slide itself may then be wiped also with benzole, and it is then ready for the application of a ring.

The best ringing medium for balsam mounts is dammar dissolved in chloroform, because if it is inclined to run under the cover it will readily mix with the mounting material without leaving a visible trace behind. I find it best to apply the brush to the edge of the cover almost dry, the slide on the turntable spinning rapidly around, so as to make a track in which the dammar solution will readily flow. The second application is to be made immediately following the first, with the brush full, so that there will be a small drop of solution on the end, which is allowed to touch the edge of the cover without letting the brush itself come in contact with the glass. This is repeated until the ring is built up to the proper size. It should be borne in mind, however, that in drying, the ring of dammar will shrink considerably, and thus it is necessary to make another application after a few hours' drying.

Dammar or balsam dissolved in benzole or benzine is objectionable, because the solution will evaporate too quickly to allow of a proper building up of the ring, and if such is attempted the result will be a ring full of minute air-bubbles. White zinc cement, Brunswick black, asphaltum varnish, and other coloured cements may be employed to cover the first ring of dammar; but they should never be used alone, as they are sure to run in sooner or later, no matter how hard the balsam may be. I think that the glass-like ring obtained with dammar gives a better appearance to the slide and is more durable than any of the rings made with coloured cements.

When glycerine mountings, or objects mounted in a watery medium are to be ringed, it is necessary to first get entirely rid of any glycerine which might be on the cover or slide. To do this I apply a spring clip to the slide, which serves to hold the cover in position after it has been centered, and then wash off the surplus glycerine with a stream of water from a syringe. The slide is then set on end to dry, and a ring of a waterproof cement is applied around the cover. Such a cement may be bought under the name of Bell's cement, the composition of which is a secret. A better and less expensive cement may, however, be made by dissolving 10 grains of gum-ammoniac in 1 ounce of acetic acid (No. 8), and then by adding to this solution 2 drachms of Cox's gelatine. The resulting liquid flows easily from the brush and is waterproof, especially so if, after the ring has set, it is brushed over with a solution of 10 grains of bichromate of potash in 1 ounce of water. But what especially recommends this cement is its great adhesive power to glass, even if there should be a little glycerine on the edge of the cover. After the gelatine ring is dry, any other cement may be employed to cover it, according to the fancy of the preparer.

When a considerable number of different objects are being prepared at the same time, it is of great importance to be able to tell one from the other, so as finally to label them correctly without subjecting them to a careful microscopical examination. A paper label, under the frequent necessary handling of the slide, becomes soiled, and the writing frequently illegible; while a figure or even a full label, written with a pen upon the glass slide, will remain intact throughout the manipulations of cleaning and ringing, and at the same time can easily be removed by a little rubbing with a rag dipped in water.

In order to facilitate the finding of slides in a large collection, it is advisable to place the label bearing the name of the object always on the same end, and if two labels are used to place the one with the preparer's name on the right hand, and the other bearing the description of the object on the left."

**Cleaning Cover-glasses.***—Dr. R. U. Piper, of Chicago, has suggested a very simple method of cleaning cover-glasses without breaking them. Upon a glass plate 2 × 3 inches are cemented, in the form of a V, two thin strips of glass. A cover-glass may be laid upon the glass plate, inside of the V, and cleaned by rubbing freely, being held in position from slipping by the sides of the V.

**Preparing Sections of Coal.**—Mr. E. T. Newton, the Assistant-Naturalist of the Geological Survey, who has successfully examined the microscopical structure of many varieties of coal, gives † the following description of the methods employed by him in making his preparations:—

"One important point to be noticed at the outset is that nothing like *emery* powder can be used for the grinding, as the grains embed themselves in the softer substance of the coal, and, when the section is finished, will be seen as minute bright spots, thus giving to the section a deceptive appearance. For the rough grinding an ordinary grindstone may be used, and for the finer work and finishing a strip of 'pumice-stone' (or corundum stick), and a German hone (or Water-of-Ayr stone). The form of these which has been found most convenient is a strip about 1½ inch wide and about 6 inches long; the thickness is immaterial: one of the broader surfaces of these must be perfectly flat.

* 'Am. Nat.,' xlv. (1880) p. 465.
† F. Rutley's 'Study of Rocks' (8vo, London, 1879), p. 71.

Having selected a piece of coal with as few cracks as possible, cut off a piece with a saw about three-quarters of an inch square and perhaps one quarter of an inch thick. One of the larger surfaces is then rubbed flat on the pumice-stone, keeping it well wetted with water, and then polished upon the hone, also moistened with water. Sometimes it is found to be advantageous to soak the piece of coal in a very thin solution of Canada balsam in chloroform or benzole, as directed for softer rocks, or in a solution of shellac in spirits of wine; in either case allowing the specimen to dry thoroughly in a warm place. The polished surface is next cemented to an ordinary microscopical glass slip (3 inches by 1 inch) with the best marine glue; and this process requires care, for it is not easy to exclude all the air-bubbles, and if they are not excluded the section is very apt in the last stages to break away wherever they occur. The piece of coal is next reduced to about one-sixteenth of an inch by means of a grindstone; some of the softer kinds may be cut down with a penknife. Care should be taken not to scratch the glass in the process of grinding, for most sections of coal, when once ground thin, are too fragile to allow of their being removed from the glass, but have to be covered and finished off upon the same slide. The pumice-stone or corundum stick is next brought into use. The section being turned downwards, hold the glass slide between the middle finger and thumb, whilst the forefinger is placed upon the centre of the slide. In this manner the section may be rubbed round and round over every part of the pumice, using plenty of water, until it is sufficiently reduced in thickness; experience alone showing how far this process may be carried. The section is finally rubbed in a similar manner upon the hone (or Water-of-Ayr stone). It is sometimes found necessary to use the hone even while the section is absolutely opaque, for many coals are so brittle that they crumble to pieces upon the pumice long before they show any indications of transparency. When sufficiently transparent the section may be trimmed with a penknife and the superfluous marine glue cleaned off.

The section is now to be moistened with turpentine, a drop of ordinary Canada balsam (not too hard) placed upon it, and covered in the usual way. Whatever heat is necessary should be carefully applied to the cover-glass by reversing the slide for a moment or so over a spirit lamp, otherwise the marine glue may be loosened and the section spoiled. Balsam dissolved in benzole must not be used for mounting, as the benzole softens the marine glue, and a good section may in this way be destroyed."

**Cutting Rock Sections.**—Mr. Hanks considers it a mistake to cut a rock section so thin as to be wholly transparent. In some cases this is necessary; but, as a general rule, the section should be left as thick as possible, and strongly lighted by the aid of a parabolic reflector. The beauty of many specimens is destroyed in the effort made to fit them for observation by simple transmitted light. Mr. Attwood's plan * to cement the section to a glass slide, and to examine it from time to time under the Microscope as the work progresses, is very important, as it will enable the student to stop at

* *Ante*, p. 325.

the exact point when light can be passed through it, but before many of the most interesting features are destroyed by over-cutting.

**Simple Mechanical Finger.***—The devices hitherto employed as "Mechanical Fingers" depend, Mr. M. A. Veeder writes, upon the lengthening of the part which supports the substage apparatus by means of a tube specially fitted for the purpose, or by means of the paraboloid, so that by a rack movement the slide may be lifted free from the stage into contact with a hair or fine wire, which is held by the stage forceps or by some contrivance designed especially for the purpose. Contact having thus been established, the slide may be lowered, leaving the object adhering to the hair, or by moving the sliding stage the object may be pushed in any direction desired. There is, however, another plan, which he finds to be simpler, and even more effective in certain respects. With many Microscopes a condensing lens is supplied, which is fitted to the limb of the instrument by a ball-and-socket joint and sliding stem-rod. Unscrew this lens and put in its place a piece of cork through which a needle passes at a right angle to the stem. It is well to have two or three pieces of cork fitted with needles having different points; one, for instance, may have a human hair projecting slightly beyond its point, the hair being kept in place by winding with fine thread and coating with gum; another may have a flat point, made by breaking off and grinding the fractured end; other forms will suggest themselves as experience may determine. The ball-and-socket joint should be clamped or wedged, so as to move quite stiffly. Bring the point of the needle into view under the objective, and it may be made to touch the slide, or be lifted away from it by simply turning the stem-rod. Objects which are seen to adhere to the needle are lifted at once, and another slide, slightly moistened by breathing on it, may be substituted for the one on the stage, to which the objects may be made to adhere at any desired point by turning the stem-rod as before. By moving the mechanical stage while the point of the needle is in contact with the slide, objects may be pushed wherever desired on the slide. In this case it is a decided advantage that both needle and object remain within view however the stage is moved. Thus dirt may be scraped away with the greatest ease.

It is evident that such a contrivance, consisting essentially of a ball-and-socket joint, and a sliding stem with a button attached to the latter, so that it may be readily turned, might be fitted to the stand of an ordinary bull's-eye condenser, and thus become available for use with any microscope-stand.

**Slides from the Naples Zoological Station.**—At the June meeting of the Society some slides were exhibited (for the most part illustrating the early stages of Invertebrates †), sent by the Zoological Station at Naples through Mr. A. W. Waters. Microscopists will be glad to hear that the Station have commenced a department under the management of Mr. Fritz Meyer for the preparation of microscopical objects on a large scale, a list of which they intend shortly to issue.

* 'Am. M. Micr. Journ.,' i. (1880) p. 88.

† See list, *post*, p. 736.

If the slides are generally of the character of those exhibited the supply must, we are afraid, for some time fall short of the demand, as there will be few biologists who will not desire to add some of the slides to their cabinet.

**Homogeneous-Immersion Lenses.***—Mr. A. A. Bragdon, referring to the strong impression prevalent among microscopists that objectives having high interior angles, say 90° and upwards, are of no use except to amuse diatomists, says that this is by no means the true state of the case. On comparing the definition obtained with a water-immersion objective of 105° interior angle (by Tolles) with other lenses having 120° or 140° air angle, the image with the latter was shown to be unsatisfactory. And again on comparing the water-immersion with the same maker's recent homogeneous-immersion having 127° interior angle, the advantage was decidedly with the latter. He refers to the series of microphotographs by Dr. J. J. Woodward † of *A. pellucida* mounted in balsam, with Zeiss's $\frac{1}{12}$ and $\frac{1}{8}$ oil-immersions, together with other notable objectives for comparison of their respective merits. Among these lenses were a $\frac{1}{6}$ and $\frac{1}{10}$ inch by Spencer, glycerine-immersion, and a $\frac{1}{10}$-inch oil-immersion by Tolles, and says that "it is only necessary for any unprejudiced person to examine this series of photographs to decide at once as to the superiority of the homogeneous-immersion lenses in defining power."

Mr. Bragdon approves of Mr. Tolles retaining the screw-collar with homogeneous-immersion lenses for these reasons,—that it affords a means of using water as an immersion medium when several preparations are being mounted of one kind, and it is desired to make a cursory examination of them at once with high powers before any change shall have taken place, and without waiting for covers to become fixed by hardening of the balsam; the collar-adjustment is also useful, even with the homogeneous-immersion, to obtain the best image with different lengths of draw-tube.

**Fluid for Homogeneous Immersion.**‡—Mr. Bragdon finds that the best medium for homogeneous immersion is glycerine brought up to the required index by making a saturated solution with it and sulpho-carbolate of zinc: there is only one, and that not a serious, objection to its every-day use, viz. that it is just a little too thick.

Dr. Blackham also says § that "good heavy glycerine is the best immersion medium he has found out of many; it does not evaporate, soften cement used in mounting objects, nor smell badly, is not poisonous nor irritant, and is in every way satisfactory."

**Errors of Refraction in the Eyes of Microscopists.**‖—Dr. J. C. Morgan points out that the requirements in construction and adjustment of glasses and the results of work done must vary greatly with

* 'Am. M. Micr. Journ.,' i. (1880) pp. 89-93.
† See this Journal, ii. (1879) p. 672.
‡ 'Am. M. Micr. Journ.,' i. (1880) p. 92.
§ 'Engl. Mech.,' xxxi. (1880) p. 400.
‖ 'Am. Journ. Micr.,' v. (1880) p. 91.

individualities of the workers' eyes, of which one of the most important, but least thought of, is astigmatism. Owing to this defect, the later pictures of Turner are found to be distorted, the tendency being to exaggerate the size of the paler dimension in painting it. On the contrary, in microscopical drawing (as with the camera lucida) the improperly pale line will be perpetuated and the perspective misrepresented. Distortion of dimensions generally may be perpetrated by the most careful observers, and endless disputes may thus arise. A familiar example of this is shown in the case of the *Podura* scale.

**Micrometre or Micromillimetre.***— Dr. Phin points out that "micrometre" is inadmissible in America at least, as it would there be spelt "micrometer," and confounded with the instrument of that name, a difficulty which the difference in pronunciation would not remedy. He thinks, therefore, that the proper way is to "fall into line" with the British Association Committee, and adopt the nomenclature suggested by Mr. Stoney, calling the thousandth of a millimetre (or the millionth of a metre) a $\frac{1}{10^6}$ or *sixth-metre*—the prefix *sixth* here indicating the negative exponent of 10 by which the metre is to be multiplied.

**Micrometry and Collar-adjustment.**†—Dr. Beale, in his 'How to Work with the Microscope,' recommends that scales be drawn or printed, showing the size to which hundredths or thousandths of the inch or centimetre are magnified by each of the objectives used, and one of these scales corresponding to the objective employed, pasted on every drawing. A writer in the 'American Monthly Microscopical Journal' recalls the fact that in all objectives made with a collar-adjustment, the magnification at the "open" and "closed" points varies so much, that attention to this is necessary in making the scales as suggested. Whilst the fact is well known, the amount of the difference does not seem to have been sufficiently taken into account. This will be best illustrated by a table showing the variations in a few objectives of well-known makers, taken with a tube 10 inches in length, measured from the stage-micrometer to the end of the tube proper (not to the end of the eye-piece):—

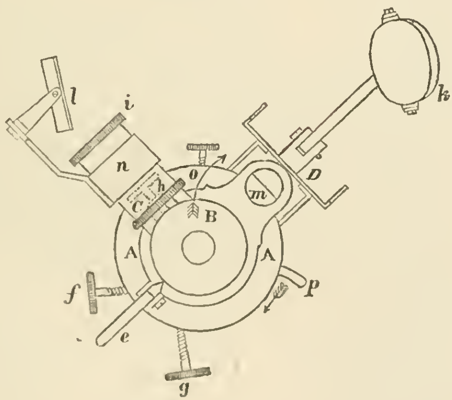
| Objective. | Oculars. | | |
|---|---|---|---|
| | A. | B. | C. |
| Geo. Wale, $\frac{1}{6}$ inch, open .. .. .. | 262 | 433 | 680 |
| ,, ,, closed .. .. .. | 283 | 466 | 725 |
| Powell and Lealand, $\frac{1}{8}$ inch, open .. | 392 | 650 | 1025 |
| ,, ,, ,, closed .. | 500 | 833 | 1300 |
| Spencer and Sons, $\frac{1}{10}$ inch, open .. | 462 | 750 | 1200 |
| ,, ,, ,, closed .. | 533 | 887 | 1400 |
| Wm. Wales, $\frac{1}{15}$ inch, open .. .. .. | 517 | 850 | 1350 |
| ,, ,, closed .. .. | 733 | 1200 | 1900 |

* 'Am. Journ. Micr.,' p. 117.
† 'Am M. Micr. Journ.,' i. (1880) p. 67.

It will be seen that the range in magnification is greater with some lenses than with others, the difference increasing with the increase of power, but with all it is so great, that scales made without taking it into account would be worse than useless. Accuracy can only be obtained by using the micrometer with the collar-adjustment at the same point at which the object sketched has been examined, unless, indeed, one were willing to take the trouble of compiling a table for each objective, with the magnification noted for each division of the collar through the whole range from "uncovered" to "covered."

**Zeiss's Microspectroscope.**—This instrument, shown in Fig. 55 (half natural size), has, in addition to a comparison-prism and arrangement for reducing the length of the spectrum, a micrometer by which the position of bright or dark lines in the spectrum is determined by *a direct reading of their wave-lengths.* For this purpose a micrometer scale is projected on the spectrum by reflection, by the divisions on which the wave-lengths at every part of the spectrum (according to Angstrom) can be directly read off in parts of a micromillimetre. The divisions on the scale read to the second decimal place; and the third decimal may be easily estimated by the eye. For convenience of recording observations there are lithographed sheets with ten scales of wave-lengths enlarged to 100 mm.

FIG. 55.




A is a shallow drum between the field- and eye-glasses of an achromatic eye-piece, and contains the 'SGravesande slits, comparison-prism, &c.

B is a cylindrical tube over the eye-piece, and contains the Amici prism. It carries the lateral tube C, which has a small achromatic objective at *o* at the focus of which at *i* is the micrometer scale. B turns on the pivot *m* and is held in the axis of the eye-piece by a catch *e*; by pressing this catch, B with all the parts attached to it may be turned about the pin *m*, so that the eye-piece is free.

D is a stage with spring clips for fixing the preparation whose spectrum is to be compared. The comparison-prism is brought up before one half of the slit by the lever *p*. The screw *f* regulates the *width* and *g* the *length* of the slit; when the latter is opened as wide as possible, the central portion of the field is free; so that the upper part (B C) being turned back, the Microscope may be used in the ordinary way. The screw *h* (underneath the tube C) serves to adjust the scale. This is to be fixed before commencing, so that the Fraunhöfer line D coincides with 0·589. The parallelism of the scale with the spectrum is secured by turning its frame *i*. The mirror *k* throws light on the comparison-prism, and *l* on the scale.

The microspectroscope is inserted in the tube of the Microscope like an ordinary eye-piece, and is fixed in the required position by an attachment screw beneath A. When the object to be examined is of considerable dimensions, no objective need as a rule be used on the tube, otherwise as low a one as possible. As a variation in the distance between the scale and the lens *o* would alter the value of the divisions of the scale, very short-sighted or long-sighted observers must use proper spectacles (or have a spectacle lens placed on B) to produce a medium distance of vision in order to see the lines and numbers on the scale with perfect sharpness of definition. For exact focal adjustment of the spectrum, the eye-glass is movable beneath the collar B. It must be so fixed that the Fraunhöfer lines in the spectrum of daylight plainly appear along with the scale, and on moving the eye there should be no appearance of parallactic displacement towards the division lines.

**Ross's Improved Microscope** (Plate XVI.).—Since this instrument was first exhibited to the Society * several improvements have been made in the details of the construction by which the stand is rendered more serviceable as a practical working instrument.

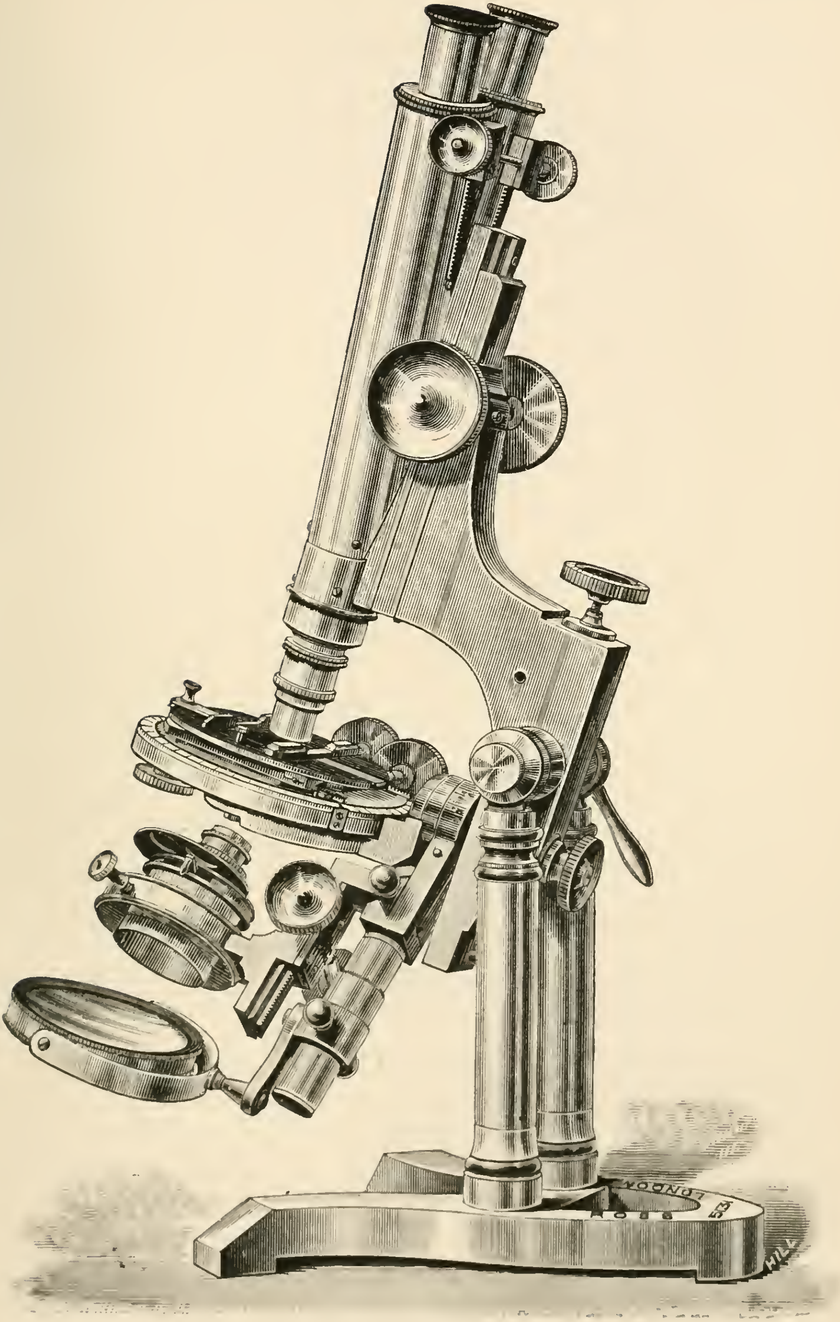
The vertical pillar supports have been adopted for the main limb, an alteration which permits the free use of the swinging substage with the Microscope in a vertical position, a point of special importance for work with fluid preparations.

For central light the substage can now be clamped in the optic axis, and the illumination exactly centered by means of the usual centering screws.

For convenience in using low powers—when the substage condenser may be dispensed with—the substage itself may be entirely removed, the mirror alone then serving as illuminator; for this purpose the focus of the mirror has been shortened, and means have been provided for more readily adjusting it to any required position.

The mechanical stage, with rotatory motion in azimuth and the facility of being inverted, has been considerably altered by the introduction of phosphor-bronze metal in the parts liable to flexure, and the stage has been rendered one of the most rigid and at the same time thinnest yet made. The modifications in the construction of the stage, though making but little change in its general appearance, are specially important in detail.

* See this Journal, i. (1878) pp. 163 and 197.



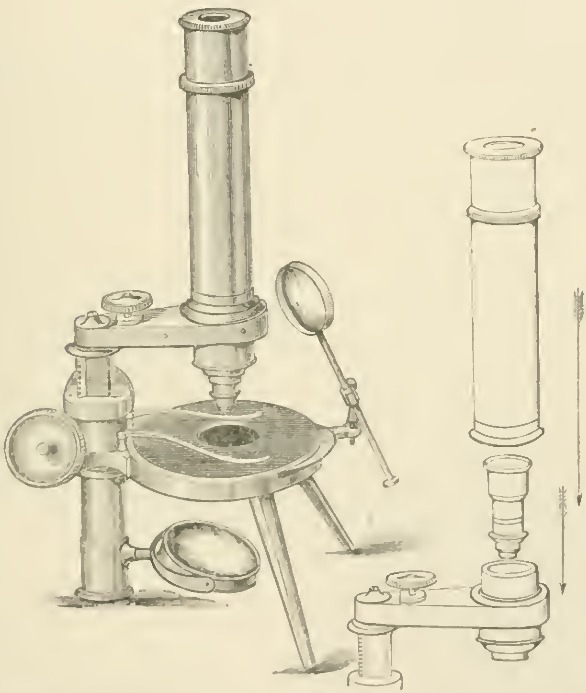
Ross's Improved Microscope.

The slow-motion focussing adjustment has been remodelled so that the focussing is extremely sensitive and yet free from all rocking motion, and the bearings of the rack and pinion movements have been increased in size, and a greater smoothness of motion obtained.

The iris diaphragm can be used either attached to the achromatic condenser or placed in the stage itself immediately beneath the object and almost on a level with the upper plane of the stage, so as to give every facility for regulating the amount of light.

**Professor Huxley's Dissecting Microscope.**—This instrument (Fig. 56), made by Messrs. Parkes and Son, of Birmingham, was arranged by Professor Huxley, and was shown by him during his term of office as President of the Quekett Microscopical Club. It is designed specially for use either as a simple or a compound Microscope, and arranged with regard to portability for travelling.

Fig. 56.



The stage—which is furnished with rotating diaphragm, and arm for carrying a condenser—consists of a circular disk of black plate glass, with a large central aperture, and is mounted on a brass tripod stand strong enough to bear considerable pressure. The arm, carrying the powers and compound body, has a coarse rack movement, and fine screw adjustment, and can be turned aside if required.

On Professor Huxley's suggestion, that the old plan of *screwing* on the objectives and compound body should be abolished, a new and more expeditious method has been adopted. Instead of screwing the body on to the arm, and then screwing the objective into the body, the objectives are made to slide down smoothly into the arm (as illustrated in the figure), and may thus be used as simple powers, for dissection. When the compound body is required, it may be instantaneously slid over the objective, and is thus ready for use, with a great saving of time and trouble.

Should it be desirable at any time to use objectives having the Society screw, provision is made for so doing, by the lower end of the tube which passes through the arm being cut with such a screw. A loose adapter having the standard screw is also supplied with each instrument, which will receive the objectives belonging to it; by screwing them into the adapter they may be used with another Microscope if necessary.

The following is the (verbal) description which Professor Huxley gave of the instrument:*—

"In a Microscope to be used for delicate dissections, certain qualifications were absolutely essential. In the first place, there must be perfect steadiness, the stand must be firmly and well supported, and be of sufficient strength and weight to bear the pressure put upon it without moving. Next, it must be of convenient height, so that in working the hands may get a steady support; it should fulfil these two conditions, and yet not be so large as to be clumsy. The next point was as to the lenses: they should be of such a form as to give a maximum of power, and yet at the same time afford sufficient distance between them and the object to admit of needles being moved freely to an angle of 60° with the surface of the plate, because the efficiency of the needles obviously depended upon the angle at which they could be used, and if a lens were made with a wide face it would very often interfere with the movements of the needles. Then there was another point of still greater importance: when a careful dissection had been made, it often became desirable to examine it with a much higher power than the one which had served the purpose of preparation, and provision ought to be made to enable as high a power as was desired to be brought to bear without disturbing the object, and this could only be done by placing a compound body above the simple lens.

[The President then exhibited the instrument which he had devised to meet these requirements as described above.]

"In offering the instrument for discussion, the question would arise as to the best form of lens to be employed, and he hoped to receive the opinions of the members upon this and other matters; but at present he used an ordinary low-power achromatic objective, made so as to slip into the arm without screwing; there was great convenience in thus mounting and using a simple lens. . . . Now, supposing they had made their dissection successfully, the point was how to be able to convert the instrument at once into a compound Microscope without disturbing either the lens or the object. One of his aims in life had been to get Microscope-makers to abolish screws, which he regarded altogether as abominable

* 'Journ. Quek. Micr. Club,' v. (1879) p. 144.

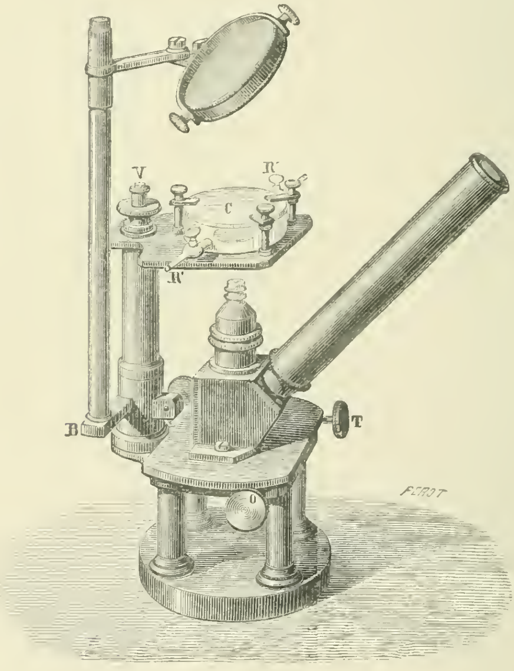
inventions; and in this instance the compound body had been made to slip over the outside of the socket in which the objective had been placed. This plan answered fairly well, but he thought it would be better to have it made to fit rather more easily, and to be secured by a bayonet joint, because, supposing that the power employed was not sufficient for the purpose, then inconvenience arose unless the body could be got off again with sufficient ease to ensure the object remaining undisturbed by any jerk or movement. With the improvement of the bayonet joint it would be easy to remove the body, and having taken out the first lens, and dropped in say a $\frac{1}{8}$-inch, the body would go on again without any disturbance. He had the instrument before them made upon that pattern, to see how the thing would work; he had used it for the past six or eight months incessantly, and he could certainly say that for his requirements it was the best thing he had seen, and he believed that with the little addition of a bayonet joint it would be as nearly perfect as any instrument of the kind could well be. He thought that all persons who had been occupied in making minute dissections would see that it had value, and met all the requirements of the most delicate work. He hoped that the members would examine and criticize it, and make any suggestions that occurred to them for its further improvement, for it was becoming of very great importance to examine thin sections and minute portions of dissections without subjecting them to any such disturbance as to cause the slightest alteration, and it was equally important to be able to bring to bear upon them under such conditions the highest powers that might be needed."

**Nachet's Chemical Microscope.***—In this Microscope (shown in Fig. 57) the objective is placed beneath the object on a brass box containing a mirror silvered on its upper surface. To this box is screwed the body containing the eye-piece and a sliding tube which is used as a coarse adjustment. The silvered surface of the mirror is entirely protected from the action of the air, as the two openings of the box are furnished with parallel glass plates. The focal adjustment is made by raising the objective and by the micrometric screw V which moves the stage. On the latter is a circular glass cell C, the bottom of which is pierced with a hole of 18 mm., closed by thin cover-glass well luted with Canada balsam or with silicate of potash. The object to be examined is placed on the thin glass. An arm B carries a mirror which reflects light from above upon the object in the cell. The latter is provided with two glass taps R R', and is covered by a disk of plane glass hermetically sealed by a little glycerine or grease placed around the edge of the cell. Three small brass uprights keep the cell and its cover in place and immovable. The instrument has a new arrangement for seeing the different parts of the preparation. The body, and consequently the objective, is moved by means of two transverse screws O and T. The plate which supports the box is furnished with two transverse divisions in connection with the movement of the screws, so as to have in effect a finder (the divisions are not represented in the figure).

* Translated (with slight alterations) from note furnished by M. Nachet.

If one reflects, M. Nachet says, on the necessity of attaching india-rubber tubes to the glass taps, and of being assured of the perfect immobility of certain anatomical elements, the advantages of the above arrangement will be at once understood. Experiments on the absorption of gas and on the rarefaction and compression of air could not be more simple. The apparatus gives at the same time a moist, a warm, and a gas chamber, and moreover the highest powers can be employed without any inconvenience. The necessary humidity required for the object is maintained by means of wetted blotting-paper, &c., placed in the cell C.

Fig. 77.




Two parts, as will be seen, are essential in this instrument—first, the moist chamber; and secondly, the arrangement of the instrument itself. As regards the latter, it is very similar to those of Dr. J. L. Smith and Dr. Leeson,* and the one hitherto made by M. Nachet; but there is this capital distinction, that the optical apparatus in the new instrument is movable in all directions, and that the object remains immovable upon the stage.

More recently M. Nachet has replaced the cell above described by smaller cells of the same kind attached to brass plates arranged so

* See Dr. W. B. Carpenter's 'The Microscope and its Revelations,' 5th ed., 1875, p. 108.

as to always have a fixed position on the stage. By means of the two transverse divisions of the plate carrying the optic apparatus, any point of the liquid under examination can be immediately refound. This is very important in researches on the culture of ferments, which are often under observation for several days, and are continually being modified. The form of the cell represented in the figure renders the Microscope inconvenient for many consecutive observations; the new plan allows the systems of culture to be multiplied indefinitely, so as to enable the necessary verifications on any desired point to be made daily. It is only necessary to take precautions when the cell is detached from the stage.

**Tiffany's Prepuce Microscope.** — Several arrangements have hitherto been devised for showing the circulation of the blood in the human subject, so as to obtain assistance in the diagnosis of disease, amongst which are the "Frænum Microscope" of Dr. Urban Pritchard,* and the apparatus devised by Dr. C. Hueter for examining the lower lip, which we recently described under the title of "Cheilo-angioscopy." †

Dr. Tiffany, of Kansas, U.S.A., suggests ‡ the prepuce as the most suitable part for the examination of the circulation. On account of its thinness, high powers with transmitted light are available for the examination. To hold the prepuce in such a position as to render the examination *very* satisfactory, he uses a thin piece of celluloid, wood, or other light substance, with clamps projecting from the under side, which fasten on each side of the lower half of the prepuce, and by thumbscrews at the free end of the instrument render it tense both laterally and longitudinally. Near the attached end of the instrument is a circular opening, $\frac{3}{4}$ inch in diameter, under which is fastened a thin cover-glass, so that the mucous membrane of the lower half of the prepuce lies in contact with this cover-glass. In this position, with the prepuce spread out nearly as thin as the web of a frog's foot, it is clamped upon the stage of the Microscope, and by transmitted light can be examined by the highest powers. A vessel should be selected which is immediately beneath the mucous membrane, and it should be pressed quite firmly against the cover-glass. Two woodcuts are given, showing the proper manner of applying the clamp and conducting the examination.

Dr. Tiffany has examined several patients, but "having no status as a guide, has scarcely been able to determine whether what was seen was normal or abnormal." He is, however, satisfied that this method will prove a valuable means of making and confirming diagnosis of constitutional diseases, as well as a means of watching the progress and effects of therapeutical agents.

**Tolles-Blackham Microscope-stand.**—Referring to the description of this stand at p. 520, Dr. Blackham writes that the substage arm is not moved circularly by the milled head B; it slides freely but

* See Dr. Beale's 'The Microscope in Medicine,' 4th ed. (1878) p. 503.

† See this Journal, ii. (1879) p. 916.

‡ 'St. Louis Med. and Surg. Journ.,' xxxviii. (1880) pp. 387–9. See also 'Louisville Med. Her.,' ii. (1880) p. 30.

firmly by hand, B being merely a clamping-screw to hold the substage apparatus in position, and is but seldom needed, though of great importance under certain conditions.

**Weber-Liel's Ear-Microscope.***—The following is the description given of this instrument in the 'Berlin Microscopical Journal':—

To the many and varied adaptations of the Microscope an addition has lately been made, the possibility of which was formerly thought to be extremely doubtful, viz. the inspection of internal parts of the human body which are difficult of access. Although such parts, as the oral cavity and auditory passage, have previously been examined by means of a lens and illuminating mirror, the low magnifying power of the apparatus set narrow limits to the examination. Now, however, the instrument of Dr. Weber-Liel has made it possible, at least for the ear, to detect the finer abnormalities of structure and in many cases to discover and remove the cause of disease.

The Microscope, which is shown in Fig. 58, consists of three principal parts:—

(1) The Microscope proper.
(2) The mirror with illuminating lens.
(3) The pneumatic chamber and flexible tube.

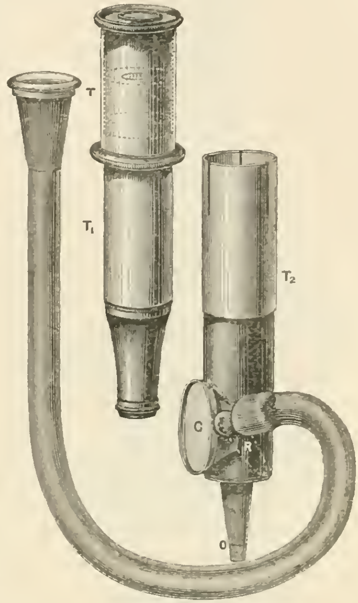
The body of the Microscope $T_2$ has a conical piece O attached to its lower extremity, several of which of different sizes are supplied with each instrument so that one may be screwed on which is adapted for the particular case and will entirely fill up the auditory passage. Above this is a chamber into the side of which an indiarubber tube opens, having a mouth-piece at its other extremity; this chamber is closed at the upper part by the mirror R which fits air-tight so that when the instrument is introduced into the ear no air has access except through the tube. The Microscope $T_1$ with the eye-piece T slides into the tube $T_2$, the eye-piece having a micrometer at *m*. The mirror which closes the pneumatic chamber is inclined at an angle of 45° to the axis of the tube, with its reflecting surface turned towards the illuminating lens G. The reflecting surface has its coating removed in the centre so that a clear view down the axis of the Microscope is obtained through it. The magnifying power of the instrument is about twenty diameters, which is strong enough for viewing the small parts of the ear, as the malleus, stapes, &c.

Besides the parts above figured and described, there should be also the ordinary speculum and two lenses. One of these lenses, magnifying about five diameters, is fixed in a short tube and inserted at $T_2$ for making a preliminary examination and (what only could hitherto be done) seeing the position of the parts. The second lens, which magnifies about three diameters, is used in making the operations. To give room for the instruments in the latter case, the cone O is replaced by one somewhat longer, which is open at the side; this of course interferes with the complete shutting-in of the pneumatic chamber, a matter, however, of no consequence as this chamber is not wanted during an operation.

* 'Zeitschr. f. Mikr.,' ii. (1880) p. 175.

If whilst the Microscope is in position the air in the external auditory passage is slightly condensed or rarefied by applying the mouth to the tube, it will be seen how the tympanic membrane and the manubrium of the malleus are respectively set in motion; and a more definite judgment can be formed as to anomalies of tension in pathological alterations of tissue. This can be exactly measured by connecting the tube with a mercurial manometer. A most important feature in connection with the instrument is the fact that by means of it the capacity for vibration of the acoustic apparatus can be studied in living persons. For this purpose, the tympanic membrane, or if this is wanting as well as malleus and incus, then the stapes must previously be sprinkled over with powdered starch, by blowing a little into the auditory passage. The starch particles appear under an intense light as strongly reflecting points. On speaking or singing loudly in the mouth-piece of the tube, it will be seen that particular particles of starch are drawn out into small lines, from which the capacity for displacement of the powdered parts, as regards the action of sounds, can be measured by means of the micrometer in the eye-piece.

Fig. 58.




The small mobility possessed by the other segments of the tympanic membrane compared with those of the posterior portions, then becomes very apparent, and especially in certain pathological conditions we are able to detect how the mobility of the parts is not reduced, but considerably increased contrary to what is usually assumed. The instrument will in general lead to conclusions respecting changes of diagnostic importance such as could in no way be supposed with the ordinary mode of examination with intense sunlight; for instance, accumulations of secretion behind the tympanic membrane, which would otherwise be invisible, can be plainly seen.

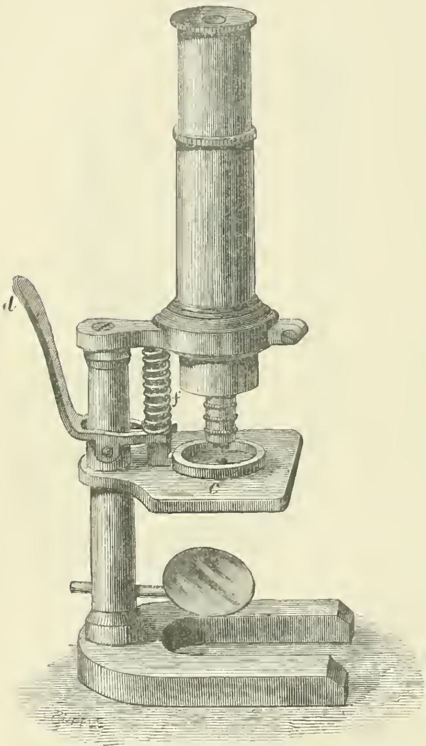
**Trichina-Microscopes—Hager's, Schmidt and Haensch's, Waechter's, and Teschner's.**—The number of Trichina-Microscopes invented in Germany is continually on the increase. The following are four forms which do not appear to have been hitherto described in this country:—

*Hager's* * is shown in Fig. 59, and is said to be very useful, not

* H. Hager, 'Das Mikroskop' (8vo, Berlin, 1879).

only in the case of *Trichinæ*, but also for vegetable tissues. It is a Microscope combined with a compressorium. The latter consists of a metal ring *c*, which is pressed upon the stage by a spring *f*, and can be released by pressing the lever *d*. The ring being raised, the object to be examined (placed between two glass plates) is laid upon the stage, and the ring is then allowed to descend gently upon the plates.

Fig. 59.




*Schmidt and Haensch's* (shown in Figs. 60 and 61) also includes a combined stage (E) and a compressorium (C) (acted upon by two screws), but has in addition a special arrangement for coarse and fine adjustment of focus. The inner tube carrying the eye-piece and objective, which slides within the outer tube attached to the pillar of the Microscope, is provided with a projecting pin which moves in a slot cut obliquely in the outer tube like the thread of a screw, so that by rotating the milled rim (B) of the inner tube it is made to slowly ascend and descend as desired.

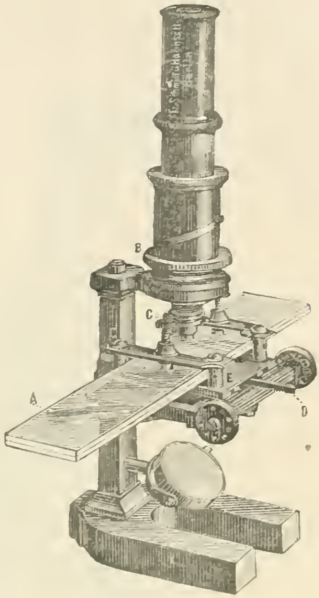
It is claimed * for this plan that it obviates a defect in centering found to exist in Microscopes with the ordinary sliding adjustment, with which it constantly happens that after the tube has been drawn up to change the powers, a suspicious spot which it was desired to examine is found to have disappeared from the field of view. The objection to the arrangement will probably be found in the tendency of the tube to "run down"; at least that was found to be so in the case of an arrangement somewhat analogous in principle, proposed by Mr. Fiddian some years ago.

The second improvement claimed is the movement of the stage in two rectangular directions by the lever A and rack and pinion D. It is pointed out that it is impossible even for a practised microscopist to move the object in the absence of mechanical appliances without missing any portion of the surface. By means of a test plate consisting of a photograph (a square German inch in size) of the numbers 1 to 700, small enough to be clearly legible under a high power, it was found that the error was as much as 30 per

* See 'Industrie-Blätter,' xvi. (1879) p. 289.

cent., and as the figures were more readily distinguishable than *Trichinæ*, the error in the latter case will probably be still greater, and a matter, therefore, of some importance. The construction and advantages of this mechanical stage are described by the inventors somewhat on first principles (much in the same way as the matter would have been dealt with fifty years ago in this country), and appear to show a greater want of familiarity with mechanical stages than we should have supposed to exist.

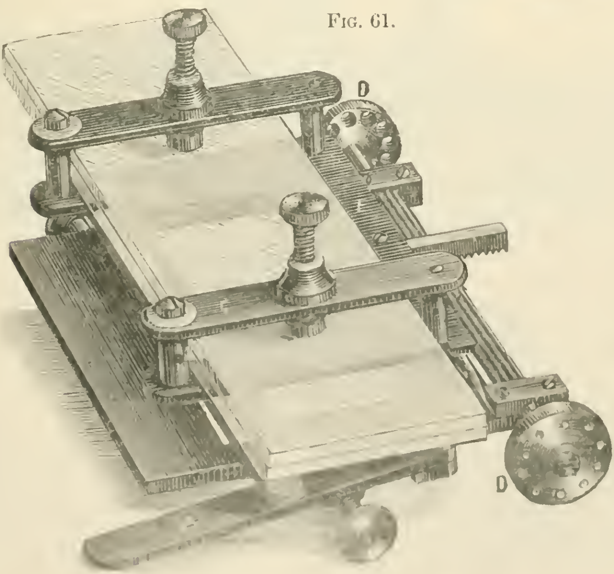
Fig. 60.




With the Microscope are supplied the two long strips of plate glass shown in the figure, between which specimens of the meat to be examined are placed. The lower and thicker one has five squares drawn upon it, each measuring a square (German) inch.

*Waechter's.** — The describer of this form suggests that, ingenious as the construction of the one previously mentioned is, it possesses several drawbacks, one of which is that " it is

Fig. 61.

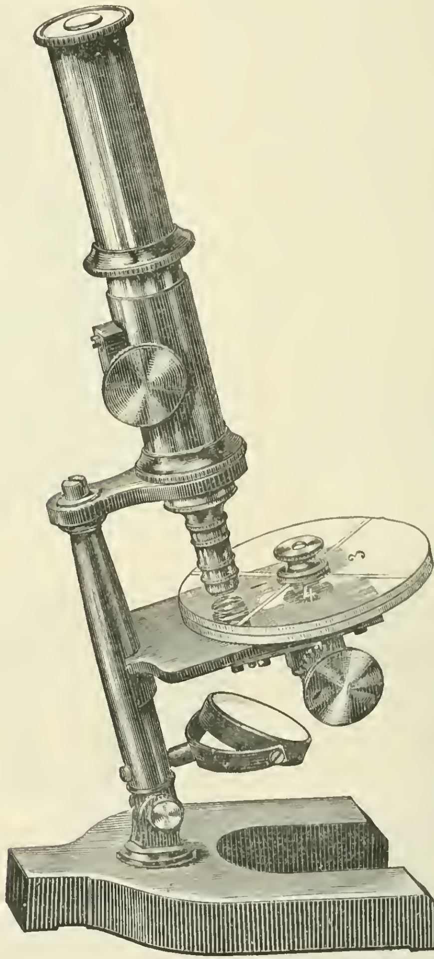



* 'Pharmaceutische Centralhalle,' i (1880) p. 102

rather complicated and if used daily for several hours would be likely to want repairing," and another, that it cannot be used as an ordinary Microscope.

In the new form, shown in Fig. 62, the slide is composed of two

Fig. 62.

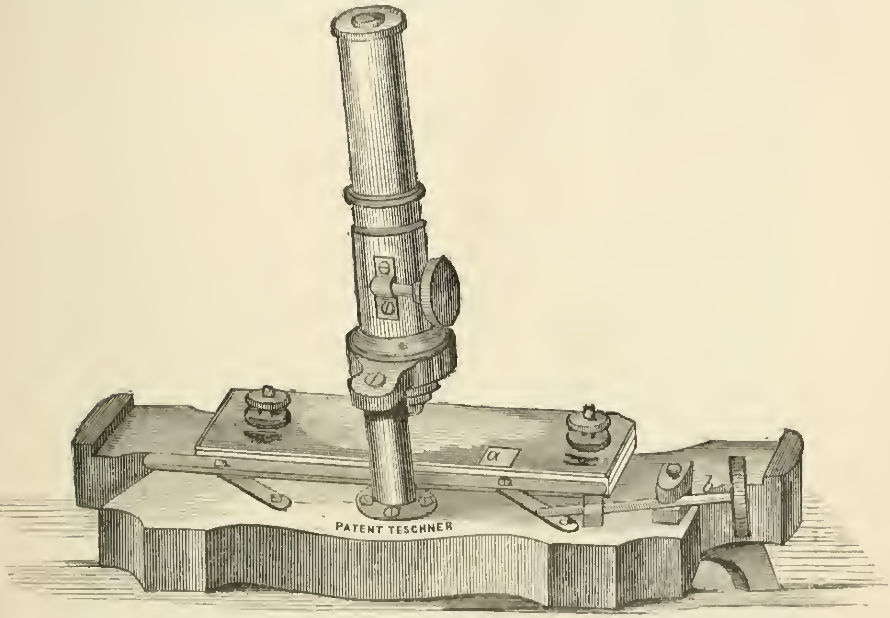


circular glass plates, 5 mm. thick and 8 cm. in diameter, which are pressed firmly together by a metal knob at their centre. They thus form a compressorium at the same time. The under plate, which may of course be thickly covered with the preparations, is divided into four sections, which are numbered for identification. To prevent any fluid coming away, the under plate may be made a very little larger than the upper.

These plates are turned with the finger about their axis (which is fixed to the stage so as to move from behind forwards, and *vice versâ*), an arrangement which allows the examination of a continuous series of preparations lying in the peripheries of different circles 18 to 24 cm. in circumference, whilst by the instrument last described a continuous line of only about 3 cm. in length can be examined.

When one periphery has been examined (which is indicated by a catch-spring), a rack and pinion moves the plates in a radial direction (as a rule it is best to begin with the inner circle), and they are again

FIG. 63.




revolved; and so on until the last periphery has been examined. There is here the great advantage that in adjusting a fresh circle the size of the field corresponding with the power used can be taken into account. Thus the lowest power requires the rack to be moved three teeth, the medium power two teeth, and the highest power one tooth forward.

When the plates are removed from the stage the instrument can be used as an ordinary Microscope.

*Teschner's* * is a simpler form, of the design shown in Fig. 63. It has a wide inclined stage, on which is a bar attached to two supports, after the manner of a parallel ruler. By means of the adjusting screw *b*, the bar can be moved to and from the aperture

* F. W. Ruffert, 'Mikroskopische Fleischbeschau' (8vo, Leipzig, 1880) p. 51.

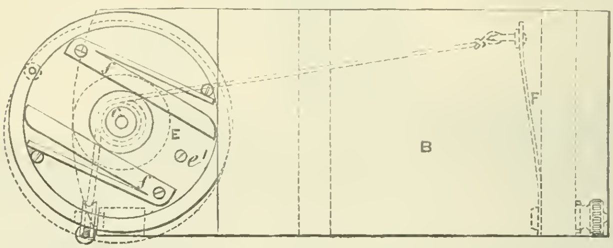
in the stage. Upon the stage is a compressorium. The bar is first brought close to the pillar of the Microscope, and the compressorium moved along it until all the flesh in that strip has been examined. The bar is then, by means of the adjusting screw *b*, advanced for a distance equal to the diameter of the field of view, and the compressorium is then moved in the reverse direction, and so on. The square *a* is said * to be a small scale for the purpose of determining the extent of movement each time. On account of the depth of the compressorium, it must be reversed in order to examine it completely.

**Matthews' Improved Turntable.**—There have been many improvements suggested in microscopical turntables, most of which have dealt with the means for securing the glass slide upon the table. Very few improvements have been made in the means for imparting the necessary rotatory movement to the table, and none which have come into general use.

Dr. Matthews' invention has for its chief object to provide a ready and efficient means for obtaining a rapid and steady rotary motion to the table, without adding materially to its complexity and consequent cost, as at present constructed. This object he effects thus:—

Fig. 64 is a plan view of the machine, and Fig. 65 a side view of the same, both figures being drawn $\frac{1}{4}$ size.

Fig. 64.

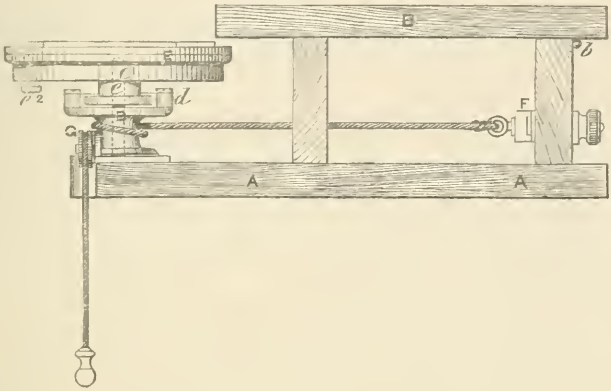



A A is a base-board of mahogany, upon which is erected the platform B which serves as a support for the wrist of the operator. This platform is hinged at *b*, so that it can be turned up out of the way when desired. Near the front end of the base-board A is secured a pivot-pin *c*'. Upon this pivot-pin is mounted, so as to turn freely, a broad flanged pulley D. Above this pulley is mounted the turntable E, also turning freely upon the pivot-pin. The under side of the turntable is provided with a short neck *e*, having a ring of ratchet teeth. The upper flange of the pulley is fitted with a spring pawl *d*, which engages with the ring of ratchet teeth on the under side of the turntable. Underneath the platform B a flat spring F is secured by one of its ends, and to the free end of this spring is attached a cord, which is led forward and passed around the pulley. It is then carried over a second pulley G, from which it hangs pendent.

* The figure is a 'cliché' from the original woodcut.

It will be readily understood from the foregoing description that by pulling downwards upon the cord a rotary movement will be imparted to the pulley D, and through the pawl and ratchet teeth to the turntable E. By relaxing the pull upon the cord, the spring F

Fig. 65.




will draw the cord back again, carrying round the pulley D and pawl *d* in the reverse direction. The weight and momentum imparted to the turntable will be sufficient to maintain its rotation during this backward movement of the pulley, and by a repetition of the process the rotation of the turntable may be continued as long as desired.

In order to hold the slide in a central position upon the turntable, two metal slips *f f* are pivoted at their opposite ends to the surface of the table. These slips are provided with springs which bear against the heads of screws on the upper side of the table. By this means the slide will always be accurately centered laterally. Its adjustment longitudinally can be effected by the aid of a ring engraved in the surface of the table.

It is often desirable, however, to apply a circle of cement excentrically. This is especially the case in re-ringing old slides. The adjustment longitudinally can be readily made as already explained, and can of course be made either central or excentric. To provide for an excentric adjustment laterally, the top of the table is formed of a movable disk, which is pivoted at $e^1$. This disk is secured in a central position by means of a milled-headed screw $e^2$. By withdrawing this screw slightly the disk is set free and can be shifted laterally as indicated by the dotted lines in Fig. 64, so that any amount of excentricity can be given to the disk, and consequently to the slide which it carries.

It is obvious that the pulley G may be placed elsewhere on the base-board A, or may be dispensed with altogether, in which case a direct pull upon the cord can be used to impart motion to the turntable.

# BIBLIOGRAPHY

OF CURRENT RESEARCHES RELATING TO

## INVERTEBRATA, CRYPTOGAMIA, MICROSCOPY, &c.

---

JOURNALS, TRANSACTIONS, &c., THE CONTENTS OF WHICH ARE NOTED IN THE FOLLOWING BIBLIOGRAPHY.

### UNITED KINGDOM.

#### England.

Annals and Magazine of Natural History, Fifth Series, Vol. V., No. 30; Vol. VI., No. 31 (June–July).

English Mechanic, Vol. XXXI., Nos. 792–99 (May 28–July 16).

Entomologist, Vol. XIII., Nos. 205–6 (June–July).

Entomologist's Monthly Magazine, Vol. XVII., Nos. 193*–4* (June–July).

Geological Magazine, Dec. II., Vol. VII., Nos. 192–3 (June–July).

Grevillea, Vol. VIII., No. 48 (June).

Hardwicke's Science-Gossip, 1880, Nos. 186–7 (June–July).

Journal of Science, Third Series, Vol. II., Nos. 78*–9 (June–July).

Midland Naturalist, Vol. III., Nos. 30–1 (June–July).

Naturalist, Vol. V., Nos. 59*–60 (June–July).

Nature, Vol. XXII., Nos. 553*–4*, 555–9 (June 3–July 15).

Popular Science Review, N. S., Vol. IV., No. 15 (July).

Quarterly Journal of Microscopical Science, N. S., Vol. XX., No. 79 (July).

Trimen's Journal of Botany, N. S., Vol. IX., Nos. 210–11 (June–July).

Zoologist, Third Series, Vol. IV., Nos. 42*–3* (June–July).

London. Entomological Society—Transactions, 1880, Part 2.

„ Geological Society—Quarterly Journal, Vol. XXXVI., No. 142 (May).

„ Palæontographical Society, Vol. XXXIV. (1880).

„ Royal Society—Proceedings, Vol. XXX., No. 204.

„ Zoological Society—Proceedings, 1880, Part 1 (June).

#### Scotland.

Scottish Naturalist, Vol. V., No. 39 (July).

Glasgow. Natural History Society—Proceedings, Vol. IV., Part 1.

---

### COLONIES.

#### India.

Calcutta. Asiatic Society of Bengal—Proceedings, 1880, No. 1* (January).

#### Canada.

Canadian Naturalist, N. S., Vol. IX., No. 5.

---

### UNITED STATES.

American Journal of Microscopy, Vol. V., Nos. 5–6 (May–June).

American Journal of Science, Third Series, Vol. XIX., No. 114 (June).

American Monthly Microscopical Journal, Vol. I., No. 6 (June).

American Naturalist, Vol. XIV., Nos. 6–7 (June–July).

Psyche, Vol. III., No. 72 (April).

Philadelphia. Academy of Natural Sciences—Proceedings, 1880 (pp. 121–52).

GERMANY.

Archiv für Mikroskopische Anatomie, Vol. XVIII., Part 3.

Archiv für pathologische Anatomie und Physiologie und für Klinische Medicin (Virchow), Vol. LXXX., Parts 2-3.

Botanisches Centralblatt, Nos. [2-3] [4-5] 6, [7-8] [9-10]*, 11-13, 14*, 15, 16*-18*, 19, 20*.

Botanische Zeitung, Vol. XXXVIII., Nos. 18-25, 26*.

Entomologische Nachrichten, Vol. VI., Nos. 11-14.

Entomologische Zeitung (Stettiner), Vol. XLI., Nos. [4-6].

Flora, Vol. LXIII., Nos. 15-18, 19*, 20 (May 21-July 11).

Hedwigia, Vol. XIX., No. 6 (June).

Jenaische Zeitschrift für Naturwissenschaft, N. S., Vol. VII., Part 2.

Kosmos, Vol. IV., Part 4 (July).

Naturforscher, Vol. XIII., Nos. 23-24, 25*, 26, 27*-28* (June 5-July 10).

Zoologischer Anzeiger, Vol. III., Nos. 57-60 (June 7-July 12).

Berlin. K. Preussische Akademie der Wissenschaften—Monatsbericht, 1880. February*-March*.

Dresden. Naturwissenschaftliche Gesellschaft 'Isis'—Sitzungsberichte, 1879 (July-December).

Jena. Medicinisch-Naturwissenschaftliche Gesellschaft — Denkschriften, Vol. II., Part 4*.

Munich. K. Bayerische Akademie der Wissenschaften—Sitzungsberichte, 1880, Part 3.

Würzburg. Physikalisch-Medicinische Gesellschaft—Verhandlungen, N. S., Vol. XIV., Parts [3-4].

AUSTRIA-HUNGARY.

Oesterreichische Botanische Zeitschrift, Vol. XXX., Nos. 6-7 (June-July).

Trieste. Società Adriatica di Scienze Naturali—Bollettino, Vol. V., No. 2.

Vienna. Embryologisches Institut der K.-K. Universität — Mittheilungen, Vol. I., Part 4.

HOLLAND.

Archives Néerlandaises des Sciences exactes et naturelles, Vol. XV., Parts 1-2.

Amsterdam. K. Akademie van Wetenschappen—Verslagen en Mededeelingen, Second Series, Vol. XV., Part 2.

Leiden. Royal Zoological Museum of the Netherlands—Notes, Vol. II., No. 2 (April).

DENMARK.

Copenhagen. K. Danske Videnskabernes Selskab—Skrifter, Fifth Series, Vol. XI., No. 6. Oversigt, 1879, No. 3*; 1880, No. 1.

SWEDEN AND NORWAY.

Botaniska Notiser, 1880, No. 3 (May).

Nyt Magazin for Naturvidenskaberne, Vol. XXV., Parts 2, 3, 4.

Stockholm. K. Vetenskaps Akademien—Öfversigt, Vol. XXXVI., Parts [1-2]* [3-4] and [5-6] [7-8]* [9-10].

SWITZERLAND.

Bern. Naturforschende Gesellschaft—Mittheilungen, 1879, Nos. [962-78].

Lausanne. Société Vaudoise des Sciences Naturelles—Bulletin, Second Series, Vol. XVI., No. 83.

St. Gallen. Schweizerische Naturforschende Gesellschaft — Verhandlungen, Vol. LXII*.

FRANCE.

Annales des Sciences Naturelles (Botanique), Sixth Series, Vol. IX., No. 4.
" " (Zoologie), Sixth Series, Vol. IX., No 1.

Archives de Physiologie normale et pathologique (Brown-Séquard), Second Series, Vol. VII., Nos. 1*-2* (January-April).

Brebissonia, Vol. II., Nos. [10-11] (April-May).

Bulletin Scientifique du Département du Nord, Vol. III., Nos. 4-5 (April-May).

Guide du Naturaliste, Vol. II., Nos. 6* [7-8] [9-10]* (March 31-May 31).

Journal de l'Anatomie et de la Physiologie (Robin), Vol. XVI., No. 4* (July-August).

Journal de Conchyliologie, Third Series, Vol. XX., No. 2.

Journal de Micrographie, Vol. III., Nos. 11-12 (November-December); Vol. IV., No. 1 (January).

Revue Internationale des Sciences Biologiques, Vol. V., No. 6* (June).

Revue des Sciences Naturelles, Second Series, Vol. II., No. 1 (June).

Paris. Académie des Sciences—Comptes Rendus, Vol. XC., Nos. 21-4, 25*, 26; Vol. XCI., No. 1 (May 24-July 5).

BELGIUM.

Brussels. Académie Royale des Sciences, &c., de Belgique—Bulletin, Vol. XLIX, No. 4*.

ITALY.

Michelia, 1880, No. 6.

Milan. Società Crittogamologica Italiana—Atti, Second Series, Vol. II., Part 2.

Modena. Società dei Naturalisti—Annuario, Second Series, Vol. XIV., Parts [1-2]*.

Padua. Società Veneto-Trentina di Scienze Naturali—Bullettino, Vol. I., No. 4 (June).

Pisa. Società Toscana di Scienze Naturali—Atti (Processi Verbali, pp. 53-64).

Rome. R. Accademia dei Lincei—Atti, Third Series, Transunti, Vol. IV., Part 6 (May).

SPAIN.

Madrid. Sociedad Española de Historia Natural—Anales, Vol. IX., Part 1.

## ZOOLOGY.

### A. GENERAL, including Embryology and Histology of the Vertebrata.

Arndt, R.—Observations on the Red Medulla of Bone. Plate 10, figs 1-4.
*Arch. path. Anat. & Physiol. (Virchow)*, LXXX., pp. 385-95.

Arnstein, C.—Historical Note on the Perilymphatic Capillary Network.
*Arch. Mikr. Anat.*, XVIII., pp. 345-6.

Balbiani, E. G.—Fecundation in the Vertebrata. X.-XI.
*Journ. de Microgr.*, III., pp. 470-6, 512-16; IV., pp. 10-13.

Balfour, F. M.—A Treatise on Comparative Embryology. Vol. I. 492 pp., 275 figs. (8vo. London, 1880.)

" " On the Structure and Homologies of the Germinal Layer of the Embryo. 17 figs. *Quart. Journ. Micr. Sci.*, XX., pp. 247-73.

BRAUN, M.—On the Developmental-history of the Parrots. II.
*Verh. Phys.-Med. Gesell. Würzburg*, XIV., pp. 251–2.

COSTERUS, J. C.—The Influence of Saline Solutions on the Duration of the Life of Protoplasm. *Arch. Néerl. Sci. exact. & nat.*, XV., pp. 148–54.

FLEMMING, W.—On Epithelium-regeneration, and the so-called free Nucleus-formation. (Supplement to his Paper on "The Cell and its Vital Phenomena.")
*Arch. Mikr. Anat.*, XVIII., pp. 347–64.

FLESCH, M.—On the Cell and Intercellular-substance in Hyaline Cartilage.
*Verh. Phys.-Med. Gesell. Würzburg*, XIV., *SB.*, pp. iii.–vi.

FOX, L. W.—The Asymmetry of the Face in Human Embryos.
*MT. Embryol. Inst. K.-K. Univ. Wien*, I., pp. 279–85.

FRANKLAND, E.—On the Spontaneous Oxidation of Organic Matter in Water.
[*Journ. Chem. Soc.*, XXXVII., pp. 517–46.]

GIBBES, H.—On the Structure of the Spermatozoon. 1 fig.
*Quart. Journ. Micr. Soc.*, XX., pp. 320–1.

HALPRYN, P.—Communications on the Results of an Investigation on a premature Human Embryo. Plate 22, 23–4.
*MT. Embryol. Inst. K.-K. Univ. Wien*, I., pp. 235–54.

HANNOVER, A.—The Primordial Cartilage and its Ossification in the Human Skull before Birth. 2 plates (explanation in French).
*K. Dansk. Vidensk. Skr. (Copenhagen)*, XI., pp. 354-528.

*Hanstein, J. v.*—The Influences of Cell-nuclei on the Division of Cells. [*Abstr.* from 'SB. Niederrhein. Gesell. Natur. und Heilk. Bonn,' 1879, p. 145.]
*Naturf.*, XIII., pp. 220–1.

HOGG, J.—Impure Drinking-water—its Sanitary Import. 11 figs.
*Engl. Mech.*, XXXI., pp. 425–6.

HORVÁTH, G. v.—On Periodic Phenomena in the Animal World (*concld.*).
*Entomol. Nachr.*, VI., pp. 109–15.

JOURDAIN, S.—On the Existence of a Lymphatic Circulation in *Pleuronectes*.
*Comptes Rendus*, XC., pp. 1430–2.

*Knop, W.*—On Albuminous Bodies. [*Abstr.* from 'Berichte üb. d. Verh. Sächsisch. Gesell. Wiss. Leipzig,' 1879, p. 1.] *Naturf.*, XIII., pp. 219–20.

KRAUSE, E.—Notes on the Developmental-history of Embryology.
*Kosmos*, IV., pp. 257–75.

KRAUSE, W.—On a premature Human Embryo. *Zool. Anzeig.*, III., pp. 283–4.

LIPPINCOTT, J. S.—The Critics of Evolution (*contd.*).
*Am. Nat.*, XIV., pp. 398–416.

NEUMANN, E.—On Degeneration and Regeneration of Injured Nerves. Plate 16. *Arch. Mikr. Anat.*, XVIII., pp. 302–44.

PECK, M. R. C.—Cyst-formation in the Body-wall of the Embryo. Plate 27.
*MT. Embryol. Inst. K.-K. Univ. Wien*, I., pp. 287–91.

*Pouchet.*—The Origin of the Red Blood-corpuscles. [*Transl.* from 'Revue Scientifique.'] *Quart. Journ. Micr. Sci.*, XX., pp. 331–50.

RAWITZ, B.—On the Structure of the Spinal Ganglia. Plate 15.
*Arch. Mikr. Anat.*, XVIII., pp. 283–301.

SCHENK.—On the Influence of Colour on the Development of Animals.
*MT. Embryol. Inst. K.-K. Univ. Wien*, I., pp. 265–77.

SEDGWICK, A.—On the Development of the structure known as the "Glomerulus of the Head-kidney" in the Chick. *Quart. Journ. Micr. Sci.*, XX., pp. 372–4.

SLATER, J. W.—The "Laws of Emphasis and Symmetry."
*Journ. of Sci.*, II., pp. 434–8.

SOLGER, B.—Further Researches on the Anatomy of the Lateral Organs of Fishes. III. The Lateral Organs of the Osseous Fishes.
*Arch. Mikr. Anat.*, XVIII., pp. 364–90.

VIRCHOW, H. J. P.—Vessels of the Vitreous Body and Vascular Lens in Animal Embryos. *Verh. Phys.-Med. Gesell. Würzburg*, XIV., *SB.*, pp. xx.–xxii.

WAILLY, A.—Hybrids and Degeneracy. *Entomol.*, XIII., pp. 151–8.

WILSON, H. C.—On the Development of the Human Skin. Plates 25–6.
*MT. Embryol. Inst. K.-K. Univ. Wien*, I., pp. 255–64.

## B. INVERTEBRATA.

Asper.—Contributions to the Knowledge of the Deep-water Fauna of the Swiss Lakes (*concld.*). *Zool. Anzeig.*, III., pp. 200–7.

### Mollusca.

Barrois, T.—Notes on the Glands of the Feet in the Family of the Tellinidæ. *Bull. Sci. Dép. Nord*, III., pp. 193–7.

Call, R. E.—Polymorphous *Anodontæ*. *Am. Nat.*, XIV., pp. 529–30.

Crosse, H.—On the Identity of the Genera *Hainesia*, *Dacrystoma*, and *Mascaria*. *Journ. de Conch.*, XX., pp. 135–140.

„ „ Description of the new Genus *Pyrgophysa*. Fig. 5 of Plate 4. *Journ. de Conch.*, XX., pp. 140–2.

„ „ Description of undescribed Mollusca [4] from New Caledonia and New Britain. 4 figs. of Plate 4. *Journ. de Conch.*, XX., pp. 142–9.

„ „ Diagnoses Molluscorum novorum [3] in insula "Nossibé" dicta et in provincia Paraensi collectorum. [Latin.] *Journ. de Conch.*, XX., pp. 149–50.

Dall, W. H.—American Work in the Department of Recent Mollusca during the year 1879. *Am. Nat.*, XIV., pp. 426–36.

Esmark, B.—Essay on the Distribution of Land and Fresh-water Mollusca in different parts of Norway. 2 figs. *Nyt Mag. Naturvid.*, XXV., pp. 215–23.

Etheridge, R., jun.—Notes on the Gasteropoda contained in the Gilbertson Collection, British Museum, and figured in Phillips's 'Geology of Yorkshire.' (*In part.*) *Ann. & Mag. Nat. Hist.*, V., pp. 473–85.

Hudleston, W. H.—Contributions to the Palæontology of the Yorkshire Oolites. (*In part.*) Plates 8–9. [Mollusca.] *Geol. Mag.*, VII., pp. 289–98.

Jeffreys, J. G.—On a new Species of *Chiton* [*scabridus*] lately found on the British Coasts. *Ann. & Mag. Nat. Hist.*, VI., pp. 33–5.

Kirk, T. W.—Additions to the List of New-Zealand Marine Mollusca. *Ann. & Mag. Nat. Hist.*, VI., p. 15.

Lankester, E. R.—Dr. C. Rabl on the Pedicle of Invagination in Pulmonate Gasteropoda. *Quart. Journ. Micr. Sci.*, XX., pp. 376–7.

Morlet, L.—Supplement to the Monograph of the Genus *Ringicula* Deshays. Plates 5 and 6. *Journ. de Conch.*, pp. 150–81.

Munier-Chalmas, E.—Diagnosis generis novi Molluscorum Cephalopodorum fossilis. [Latin.] *Journ. de Conch.*, XX., pp. 183–4.

Nevill, G.—On the Land Shells, extinct and living, of the Neighbourhood of Mentone (Alpes Maritimes), with Descriptions of a new Genus and of several new Species. Plates 13–14. *Proc. Zool. Soc. Lond.* (1880), pp. 94–142.

Rabl, C.—*See* Lankester, E. R.

Stossich, M.—Synopsis of the Fauna of the Adriatic Sea. II. [Italian.] *Boll. Soc. Adriat. Sci. Nat.*, V., pp. 157–286.

Vasseur, G.—Diagnoses Molluscorum fossilium novorum. [Latin.] *Journ. de Conch.*, XX., pp. 182–3.

Vayssière.—Anatomical Researches on the Mollusca of the Family of the Bullidæ. (*In part.*) Plates 1–3. *Ann. Sci. Nat.* (*Zoologie*), IX., pp. 1–64.

Whitfield, R. P.—On the occurrence of true *Lingula* in the Trenton Limestones. 2 figs. *Am. Journ. Sci.*, XIX., pp. 472–5.

Wright, T.—Monograph of the Lias Ammonites of the British Islands (*contd.*). Part III. Classification. pp. 165–264. Plates 19–40, and 168 figs. 4to. [Palæontographical Society, XXXIV.] 1880.

Young, J.—On the species of *Dentalium* found in the Carboniferons Strata of the West of Scotland. *Proc. Nat. Hist. Soc. Glasgow*, IV., pp. 69–70.

### Molluscoida.

Davidson, T.—A Monograph of the British Fossil Brachiopoda. Vol. IV. Part 3. Supplement to the Permian and Carboniferous Species. pp. 243–315. Plates 30–7. 4to. [Palæontographical Society, XXXIV.] 1880.

Hincks, T.—Contributions towards a general History of the Marine Polyzoa. Plates 9–11. (*In part.*) *Ann. & Mag. Nat. Hist.*, VI., pp. 69–92.

Oehlert, D.—The Systematic Position of the Brachiopoda according to M. Morse. *Journ. de Conch.*, XX., pp. 109–35.

Shrubsole, G. W.—A Review and Description of the various Species of British Upper Silurian Fenestellidæ. Plate 11. *Quart. Journ. Geol. Soc.*, XXXVI., pp. 241–54.

Young, J.—On *Rhynchopora*, a Genus of Brachiopod Shells, new to Carboniferous Strata. *Proc. Nat. Hist. Soc. Glasgow*, IV., pp. 13–14.

## Arthropoda.

### α. Insecta.

Adolph, G. E.—On Insects' Wings. 6 plates. [From 'Nova Acta K. Leop.-Carol.-Deutschen Akad. Naturf.,' XLI., Part 2, No. 3.] (4to. Halle, 1879.)

*Berlese, A.*—See *Canestrini, G.*

Cameron, P.—Notes on the Coloration and Development of Insects. *Trans. Entomol. Soc. Lond.*, 1880, pp. 69–79.

*Canestrini, G., and A. Berlese.*—On a little-known Organ of the Hymenoptera. [Abstr.] *Bull. Soc. Ven. Trent. Sci. Nat.*, I., pp. 154.

Gorham, H. S.—On the Structure of the Lampyridæ with reference to their Phosphorescence. *Trans. Entomol. Soc.*, 1880, pp. 63–7.

„ „ Materials for a Revision of the Lampyridæ. *Trans. Entomol. Soc.*, 1880, pp. 83–112.

Hagen, H.—Remains of Branchiæ in a Libellulid—Smooth Muscle-fibres in Insects. *Zool. Anzeig.*, III., pp. 304–5.

Joseph, G.—Preliminary Communication on the Innervation and Development of the Spinning Organs of the Insecta. *Zool. Anzeig.*, III., pp. 326–8.

King, H. S.—Life-history of *Pleotomus pallens* Lec. *Psyche*, III., pp. 51–3.

Kolbe, H.—The Nervures of the Psocidæ, and their value in Classification. 1 plate. *Stett. Entomol. Zeit.*, XLI., pp. 179–86.

Lichtenstein, J.—Life-history of *Pemphigus bursarius* (Aphis) Linn. *Stett. Entomol. Zeit.*, XLI., pp. 218–22.

Morris, C.—Habits and Anatomy of the Honey-bearing Ant. *Journ. of Sci.*, II., pp. 430–4.

Packard, A. S., jun.—The Hessian Fly. 43 pp., 2 plates, and 1 fig. [Bull. No. 4 of the U.S. Entomol. Commission.] (8vo. Washington, 1880.)

Reichenau, W. v.—The Odoriferous Apparatus of *Sphinx ligustri*. *Entomol. Nachr.*, VI., p. 141.

Rietsch.—On N. Bobretsky's Studies on the Formation of the Blastoderm and Germinal Layers in the Insecta. *Rev. Sci. Nat.*, II., pp. 54–60.

Torge.—Natural History of *Eugonia fuscantaria* Hübn. *Stett. Entomol. Zeit.*, XLI., pp. 213–17.

Vayssière, A.—On the Metamorphosis of *Prosopistoma*. *Comptes Rendus*, XC., pp. 1370–1.

Wighton, J.—Notes on the Combs of Bees. *Sci.-Gossip*, 1880, p. 127.

### γ. Arachnida.

Bryan, G. H.—Notes on the Nests of European Trap-door Spiders (*contd.*). 3 figs. *Sci.-Gossip*, 1880, pp. 127–8.

Hasselt, A. W. M. van.—Contribution to the Knowledge of *Lipistius desultor* Schiödte. 3 figs. *Versl. & Mededeel. K. Akad. Wet. Amsterdam*, XV., pp. 186–96.

„ „ Supplement on *Anetes cœletron* Menge. *Versl. & Mededeel. K. Akad. Wet. Amsterdam*, XV., pp. 196–8.

Mégnin.—On a peculiar Modification of a Parasitic Acarian. *Comptes Rendus*, XC., pp. 1371–3. *Transl. Ann. & Mag. Nat. Hist.*, VI., pp. 99–100.

Pichard, P.—On an Acarian Destroyer of the Gallicolar Phylloxera. *Comptes Rendus*, XC., pp. 1572–3.

Workman, T.—A Contribution towards a List of Irish Spiders. *Entomol.*, XIII., pp. 125–30.

### δ. Crustacea.

Boas, J. E. V.—*Lithodes* and *Pagurus*. *Zool. Anzeig.*, III., pp. 349–52.

Brady, G. S.—A Monograph of the Free and Semi-parasitic Copepoda of the British Islands. Vol. II., 182 pp. Plates 34–82. (8vo. London, 1880.)

*Brandt, E.*—On the Nervous System of *Idothea entomon*. [*Transl.* from 'Comptes Rendus,' XC.] *Ann. & Mag. Nat. Hist.*, VI., pp. 98–9.

Etheridge, R., jun. – *See* Nicholson, H. A.

Fraisse, P.—The occurrence of *Branchipus Grubii* (Dybowsky) in the neighbourhood of Würzburg. *Zool. Anzeig.*, III., pp. 284–6.

Hesse.—Description of two new Crustacea, Male and Female, of the Genus *Dinemoura*, described and figured from living individuals. Plate 1. *Rev. Sci. Nat.*, II., pp. 5–15.

Kingsley, J. S.—Progress of American Carcinology in 1879. *Am. Nat.*, XIV., pp. 498–503.

„ „ Carcinological Notes. No. II.—Revision of the Gelasimi (*in part*). *Proc. Acad. Nat. Sci. Philad.*, 1880, pp. 135–52.

Kirk, T. W.—Description of a new Species of *Palinurus* [*tumidus*]. *Ann. & Mag. Nat. Hist.*, VI., pp. 14–15.

Kolmodin, L.—Ostracoda Silurica Gotlandiæ. Plate 19. [Latin.] *Öfvers. K. Vet.-Akad. För.*, XXXVI., No. 9, pp. 133–9.

Man, J. G. de.—On some Species of *Gelasimus* Latr. and *Macrophthalmus* Latr. [English.] *Notes R. Zool. Mus. Neth.*, II., pp. 67–72.

Miers, E. J.—On a Collection of Crustacea from the Malaysian Region. Part IV., Penæidea, Stomatopoda, Isopoda, Suctoria, and Xiphosura (*concld.*). Plate 15. *Ann. & Mag. Nat. Hist.*, V., pp. 457–72.

Nicholson, H. A., and R. Etheridge, jun.—A Monograph of the Silurian Fossils of the Girvan District in Ayrshire. Fasc. II., pp. 137–234. Plates 10–15. (8vo. Edinburgh, 1880.)

Packard, A. S., jun.—The Structure of the Eye of Trilobites. 4 figs. *Am. Nat.*, XIV., pp. 503–8.

Rehberg, H.—Two new Crustacea from a spring in Heligoland. *Zool. Anzeig.*, III., pp. 301–4.

Richters, F.—On the Distribution of *Branchipus Grubii*. *Zool. Anzeig.*, III., p. 359.

Robertson, D.—Fresh and Brackish-water Ostracoda. [Fauna of Scotland.] 35 pp. (8vo. Glasgow, 1880.)

Thomson, G. M.—New Species of Crustacea from New Zealand. Plate I. *Ann. & Mag. Nat. Hist.*, VI., pp. 1–6.

### Vermes.

*Bobretzky, N.*—On the Copulatory Organs found by him in the Genus *Microphthalmus*. [*Abstr.* in 'Proc. Zool. Sect. 6th Meeting Russian Naturalists,' &c.] *Zool. Anzeig.*, III., pp. 139–40.

Bourne, A. G.—On the Structure of the Nephridia of the Medicinal Leech. Plates 24–5. *Quart. Journ. Micr. Sci.*, XX., pp. 283–302.

Etheridge, R., jun.—A Contribution to the Study of the British Carboniferous Tubicolar Annelida. Plate 7. (*Contd.*) *Geol. Mag.*, VII., pp. 258–66, 304–7.

Greeff, R.—The Echiurans (*Gephyrea armata*). 172 pp. 9 plates and 1 woodcut. [From 'Nova Acta K. Leop.-Carol.-Deutschen Akad. Naturf.,' Vol. XLI., Part 2, No. 1.] (4to. Halle, 1879.)

Hansen, G. A.—Annelida from the Norwegian Nordhaven Expedition of 1878. 4 plates. *Nyt Mag. Naturvid.*, XXV., pp. 224–34.

Hertwig, O.—The Chætognatha. Plates 9–14. *Jen. Zeitschr. Naturwiss.*, VII., pp. 196–311.

Hogg, J.—The Natural History of the Fluke—the Rot of Sheep. 9 figs. *Engl. Mech.*, XXXI., pp. 306–7.

Hubrecht, A. A. W.—New Species of European Nemerteans. Appendix I. [English.] *Notes R. Zool. Mus. Neth.*, II., pp. 93–8.

„ „ On the Anatomy and Physiology of the Nervous System of Nemertines. Plate 23. [*Abstr.* from 'Verh. K. Akad. Wetensch. Amsterdam,' 1880.] Plate 23. *Quart. Journ. Micr. Sci.*, XX., pp. 274–82.

Joseph, G.—On *Enchytræus cavicola* n. sp. *Zool. Anzeig.*, III., pp. 358–9.

Jourdain, S.—On a very simple Form of the Group of Worms—*Prothelminthus Hessi*, S. J. = ? *Intosia leptoplanæ* A. Giard. Plate 2. *Rev. Sci. Nat.*, II., pp. 68–74.

KRABBE, H.—Researches on the occurrence of Intestinal Worms in the Intestinal Canal of the Horse. 2 figs.
*Overs. K. Danske Vidensk. Selsk.*, 1880, pp. 33–40; *French Résumé*, pp. 9–12.
*Transl. Ann. & Mag. Nat. Hist.*, VI., pp. 96–7.

LANKESTER, E. R.—On Intra-epithelial Capillaries in the Integument of the Medicinal Leech. Plate 26.
*Quart. Journ. Micr. Sci.*, XX., pp. 303–6.

„ „ On the Connective and Vasifactive Tissues of the Medicinal Leech. Plates 27–8.
*Quart. Journ. Micr. Sci.*, XX., pp. 307–17.

LEIDY, J.—Notice of some Aquatic Worms of the Family Naides. 6 figs.
*Am. Nat.*, XIV., pp. 421–5.

„ „ On a Filaria reported to have come from a Man. 2 figs.
*Proc. Acad. Nat. Sci. Philad.*, 1880, pp. 130–1.

MÜLLER, C.—Some Remarks on the Galls on *Achillea* produced by *Anguillulæ*.
*Bot. Centralbl.*, I., pp. 187–8.

PERRONCITO, E.—Helminthological Observations on the Endemic Disease of the St. Gotthard Workmen (*Anchylostoma duodenalis*).
*Atti R. Accad. Lincei (Transunt.)*, IV., pp. 179–84.

„ „ Helminthological Observations and Experimental Researches on the Disease of the Workmen of the St. Gotthard Tunnel. *Comptes Rendus*, XC., pp. 1373–5.

VILLOT, A.—On the Organization and Development of the Gordians.
*Comptes Rendus*, XC., pp. 1569–71.

## Echinodermata.

AGASSIZ, A.—Notes on some points in the History of the Synonymy of Echini.
*Proc. Zool. Soc. Lond.*, 1880, pp. 33–8.

BELL, F. J.—On *Palæolampas*, a new Genus of the Echinoidea. Plate 4.
*Proc. Zool. Soc. Lond.*, 1880. pp. 43–9.

CARPENTER, P. H.—Some disputed points in Echinoderm Morphology.
*Quart. Journ. Micr. Sci.*, XX., pp. 322–30.

„ „ Feather-Stars, Recent and Fossil. Plates 5–6.
*Pop. Sci. Rev.*, IV., pp. 193–204.

Crinoid Stems, Notes and Observations of Adventitious Structures on. III.
*Proc. Nat. Hist. Soc. Glasgow*, IV., pp. 73–7.

DANIELSSEN, D. C., and J. KOREN.—From the Norwegian Nordhaven Expedition. Plates 1–6. *Nyt Mag. Naturvid.*, XXV., pp. 83–140.

ETHERIDGE, R., jun.—Observations on the swollen condition of Carboniferous Crinoid Stems. Plates 1 and 2. *Proc. Nat. Hist. Soc. Glasgow*, IV., pp. 19–36.

GOETTE, A.—Observations on the Embryology of the Echinodermata. 3 figs.
*Zool. Anzeig.*, III., pp. 324–6.

KOREN, J.—*See* Danielssen, D. C.

LJUNGMAN, A. W.—Catalogue of the Spitzbergen Holothurida.
*Öfvers. K. Vet.-Akad. För.*, XXXVI., No. 9, pp. 127–31.

MARTIN, K.—Revision of the Fossil Echini from the Tertiary Strata of Java. [English.] *Notes R. Zool. Mus. Neth.*, II., pp. 73–84.

WRIGHT, T.—Monograph on the British Fossil Echinodermata of the Oolitic Formations. Vol. II. The Asteroidea and Ophiuroidea (*concld.*), pp. 155–203. Plates 19–21 and 3 figs. (4to. [Palæontographical Society, XXXIV.], 1880.)

## Cœlenterata.

ALLMAN, G. J.—On *Limnocodium victoria*, a Hydroid Medusa of Fresh Water.
*Nature*, XXII., pp. 178–9, 218.

DUNCAN, P. M.—Sind Fossil Corals and Alcyonaria. 28 plates.
*Palæontol. Indica*, Ser. XIV., Vol. I., Part 1, 138 pp.

GOETTE, A.—A new Hydroid Polyp with a new kind of Reproduction. 2 figs.
*Zool. Anzeig.*, III., pp. 352–8.

HAECKEL, E.—The Organization and Classification of the higher Acraspedote Medusæ. *Kosmos*, IV., pp. 310–17.

KELLER, C.—New Cœlenterates from the Gulf of Naples. Plates 13–14, with addendum by O. Schmidt. *Arch. Mikr. Anat.*, XVIII., pp. 271–82

Krukenberg, C. F. W.—On the Quantity of Water in the Medusæ. *Zool. Anzeig.*, III., p. 306.

Lankester, E. R.—On a new Jelly-fish of the Order Trachomedusæ, living in Fresh Water. *Nature*, XXII., pp. 147–8, 177–8, 190–1, 241. *See also Zool. Anzeig.*, III., pp. 321–4.

„ „ On *Limnocodium* (*Craspedacustes*) *Sowerbii*, a new Trachomedusa inhabiting Fresh Water. Plates 30–1, and 5 figs. *Quart. Journ. Micr. Sci.*, XX., pp. 351–71.

Lapworth, C.—On the Geological Distribution of the Rhabdophora. III. Results (*contd.*). *Ann. & Mag. Nat. Hist.*, VI., pp. 16–29.

Linnarsson, G.—On the Graptolites of Gothland. Plate 10. *Öfvers. K. Vet.-Akad. För.*, XXXVI., No. 5, pp. 3–11.

*Merejowsky, C.*—On the Origin and Development of the Ovum in *Eucope* before Fecundation. [*Transl.* from 'Comptes Rendus.'] *Ann. & Mag. Nat. Hist.*, V., pp. 498–500.

„ „ On the Structure of some Coralliaria. [*Transl.* from 'Comptes Rendus.'] *Ann. & Mag. Nat. Hist.*, V., pp. 502–3.

Parkinson, C.—Notes on the Lucernariadæ. 6 figs. *Sci.-Gossip*, 1880, pp. 132–3.

Romanes, G. J.—Physiology of the Fresh-water Medusa. *Nature*, XXII., pp. 179–81.

Schmidt, O.—*See* Keller, C.

### Porifera.

Fresh-water Sponges. *Am. Journ. Micr.*, V., pp. 125–32.

Minot, C. S.—A Sketch of Comparative Embryology. IV. The Embryology of Sponges. 5 figs. *Am. Nat.*, XIV., pp. 479–85.

Vosmaer, G. C. J.—The Sponges of the Leyden Museum. I. The Family of the Desmacidinæ. [English.] *Notes R. Zool. Mus. Neth.*, II., pp. 99–164.

### Protozoa.

Bütschli, O.—Protozoa. Part I. 16 pp. and 4 plates. [Vol. I. of 'Bronn's Klassen und Ordnungen des Thier-Reichs.'] (8vo. Leipzig and Heidelberg, 1880.)

Carter, H. J.—Report on Specimens dredged up from the Gulf of Manaar, and presented to the Liverpool Free Museum by Captain W. H. C. Warren. (*In part.*) Plates 18–19, 4–6. *Ann. & Mag. Nat. Hist.*, V., pp. 437–57; VI., pp. 35–61.

Cocks, W. G.—Researches in Pond Life. II. [*Acineta*, *Vorticella*, &c.] 6 figs. *Sci.-Gossip*, 1880, pp. 155–7.

George, F. J.—The *Euglena viridis*. 1 fig. „ „ pp. 148–50.

Pantanelli, D.—Radiolaria of the Diaspro. *Atti Soc. Tosc. Sci. Nat.—Proc. Verb.*, 1880, p. 58.

„ „ and De Stefani.—Radiolaria of Santa Barbera in Calabria. *Atti Soc. Tosc. Sci. Nat.—Proc. Verb.*, 1880, pp. 59–60.

„ „ [Radiolaria in the Italian "Diaspro."] [*Boll. R. Comitat. Geol. Ital.*, 1880, Nos. 1–2.]

S., A. C.—Notes on *Vampyrella lateritia*. 1 fig. *Am. Journ. Micr.*, V., pp. 105–8.

Stefani, De.—*See* Pantanelli, D.

Vejdovský, F.—On the Rhizopoda of the Prague Springs. 4 pp. Sep. repr. *S.B. K. Böhm. Gesell. Wiss. Prag*, 1880.

---

## BOTANY.

### A. GENERAL, including Embryology and Histology of the Phanerogamia.

Bertrand, C. E.—Theory of the Bundle (*concld.*). Plates 3–5. *Bull. Sci. Dép. Nord*, III., pp. 165–85.

Coaz, J.—The Leaf and its loss of Colour. *MT. Naturf. Gesell. Bern*, 1879, *Abhl.*, pp. 11–21.

*Comes, O.*—Experimental Researches on the Action of Light on the Transpiration of Plants. [*Abstr.* from 'Rend. R. Accad. Sci. Torino.']
*Guide du Nat.*, II., pp. 175–6.

CRIÉ, L.—The Ancient Climates and the Fossil Floras of the West of France (*concld.*). *Brebissonia*, II., pp. 166–70.

ERNST, A.—On the Fertilization of *Cobœa penduliflora* (Hook. fil.).
*Naturf.*, XXII., pp. 148–9.

FLAHAULT, C.—New Observations on the Modifications of Plants according to the Physical Conditions of the Medium (*concld.*). Plates 7–9.
*Ann. Sci. Nat. (Bot.)* IX., pp. 193–207.

*Hoppe-Seyler, F.*—A further Decomposition-product of Vegetable Chlorophyll. [*Abstr.* from 'Zeitschr. physiol. Chemie,' IV., p. 193.] *Naturf.*, XIII., p. 231.

JACKSON, B. D.—Remarks on Botanical Bibliography.
*Trim. Journ. Bot.*, IX., pp. 167–77.

JUST, L.—Botanischer Jahresbericht. Vol. VI. (1878). 1st Section, Part 1. 288 pp. (8vo. Berlin, 1880.)

LEVALLOIS, A.—Presence in *Soja hispida* (Münch.) of a notable Quantity of a Substance soluble in Alcohol, and easily transformable into Glucose.
*Comptes Rendus*, XC., p. 1293.

MARIÉ-DAVY.—Meteorology applied to Agriculture and Hygiene. [Action of Heat, Light, and Water on Vegetation, &c.]
*Annuaire de l'Observ. de Montsouris*, 1880, pp. 160–306.

MOLL, J. W.—Researches on Exudation of Drops and Injection in Leaves. 2 plates. [German.]
*Versl. & Mededeel. K. Akad. Wet. Amsterdam*, XV., pp. 237–337.

MÜLLER, H.—The Importance of Alpine Flowers for the Flower-Theory.
*Kosmos*, IV., pp. 276–87.

" " Relationship of Flowers and Fruit. " " pp. 306–7.

PELLET, H.—On the Fixity of Composition of Plants—Relation between the Starch, Phosphoric Acid, and Mineral Substances in the Potato.
*Comptes Rendus*, XC., pp. 1361–3.

PHIPSON, T. L.—On a Phenomenon of Sensibility observed in *Acacia*.
*Comptes Rendus*, XC., pp. 1228–9.

*Prantl, K.*—An Elementary Text-book of Botany. *Transl.* and revised by S. H. Vines. 332 pp., 275 figs. (8vo. London, 1880.)

REINSCH, P. F.—Discovery of New Plant-forms in Coal and in Anthracite. 8 pp. 2 plates. (8vo. Cassel, 1880.)

STAHL, E.—On the Influence of Direction and Intensity of Light on some Phenomena of Motion in the Vegetable Kingdom. Plate 6.
*Bot. Zeit.*, XXXVIII., pp. 297–304, 321–43, 345–57, 361–8, 377–81, 393–400, 409–13.

TREUB, M.—On Vegetable Cells with several Nuclei. Plates 2–4. [French.]
*Arch. Néerl. Sci. exact. & nat.*, XV., pp. 39–60.

VINES, S. H.—On the Chemical Composition of Aleurone-grains.
*Proc. Roy. Soc.*, XXX., pp. 387–93.

VONHÖNE, H.—On the Sprouting of Endogenous Organs from the Mother-Organ. Plate 6. *Flora*, LXIII., pp. 227–34, 243–57, 268–71.

## B. CRYPTOGAMIA.

BAGNALL, J. E.—The Cryptogamic Flora of Warwickshire (*contd.*).
*Midl. Nat.*, III., pp. 132–5.

ENGELHARDT, H.—On the "Cypris-shale" of North Bohemia and its Vegetable Contents. Plates 7–9. [Crypt. = Fungi, 2; Characeæ, 1.]
*SB. Naturw. Gesell. Isis*, 1872, pp. 131–52.

*Eyferth, B.*—The simplest Forms of Life (*contd.*). [*Trans.* from German.]
*Am. M. Micr. Journ.*, I., pp. 115–17.

### Cryptogamia Vascularia.

BAKER, J. G.—On a Collection of Ferns made by Dr. Beccari in Western Sumatra. *Trim. Journ. Bot.*, IX., pp. 209–17.

BAUKE, H.—*See* Sachs.

CRAMER, C.—Preliminary Communication on the Asexual Propagation of the Prothallium of Ferns by means of Gemmæ or Conidia.
*Bot. Centralbl.*, I., pp. 476–8.

ETTINGSHAUSEN, C.—*See* Gardner, J. S.

GARDNER, J. S., and C. Baron ETTINGSHAUSEN.—A Monograph of the British Eocene Flora. Part 2 (*contd.*), Filices, pp. 39–58. Plates 6–11, and 12 figs. (4to. [Palæontographical Society, XXXIV.] 1880.)

GOODE, J. B.—Notes on some Canadian Ferns.
*Can. Natural.*, IX., pp. 297–301.

LEITGEB, H.—On *Dumortiera*, a Genus of the Marchantiaceæ.
*Flora*, LXIII., pp. 307–12.

ROBINSON, J. F.—Note on *Asplenium lanceolatum* (Sinelii).
*Sci.-Gossip*, 1880, p. 148.

SACHS, J.—Botanical Remains of Dr. H. Bauke. 6 plates of Prothallium of Ferns and 3 pp. text. *Bot. Zeit.*, XXXVIII. (Supplement).

VAYGREDA Y VILA, E.—Plants notable for their utility or rarity which grow spontaneously in Catalonia. II. [Crypt. Vasc., pp. 125–8.]
*Anal. Soc. Españ. Hist. Nat.*, IX., pp. 52–130.

## Muscineæ.

BRAITHWAITE, R.—The British Moss-Flora. Vol. I. Acrocarpous Mosses. Part 1. Fam. 1. Andreæaceæ. Part 2. Fam. 2. Buxbaumiaceæ. Fam. 3. Georgiaceæ. pp. 1–32. Plates 1–4. (8vo. London, 1880.)

EKSTRAND, E. V.—Notes on Scandinavian Hepaticæ (*contd.*).
*Bot. Notiser*, 1880, pp. 65–71.

LEES, F. A.—Mosses of the Wetherby District, additional to Dr. Wesley's List.
*Naturalist*, V., pp. 181–5.

LINDBERG, S.—Transition of a Female to a Male Organ in a Moss. Plate 11.
*Öfvers. K. Vet.-Akad. För.*, XXXVI., No. 5, pp. 75–8.

SANIO, C.—Commentatio de Harpidiis europæis inductiva. [Latin.]
*Bot. Centralbl.*, I. (Suppl. 2), 24 pp.

WARNSTORF, C.—Short Notices of the Moss-Flora of Salzburg and Steiermark.
*Bot. Centralbl.*, I., pp. 153–4.

„ „ On the Musci and Hepaticæ of the neighbourhood of Verviers. *Bot. Centralbl.*, I., pp. 379–81.

„ „ On the Moss-Vegetation of the Upper Valley of the Danube.
*Bot. Centralbl.*, I., pp. 412–14.

„ „ Excursions in the Unterhartz.—A Contribution to the Flora hercynica. II. Hepaticæ (*concld.*). *Hedwigia*, XIX., pp. 89–92.

## Characeæ.

GROVES, H. and J.—A Review of the British Characeæ (*concld.*) Plates 209–10. *Trim. Journ. Bot.*, IX., pp. 161–7.

## Fungi.

BARKAS, T. P.—A Microscopic Novelty. 1 fig. Vegetable or Animal? 7 figs. *Engl. Mech.*, XXXI., pp. 308, 352, 423–4, 451.

*Bary, A. de.*—On *Æcidium abietinum.* (*In part.*) Plate 10. [*Transl.* from 'Bot. Zeit.'] *Ann. Sci. Nat.* (*Bot.*), IX., pp. 208–56.

BLYTT, A.—*Clastoderma* novum Myxomycetum genus. [Latin.]
*Bot. Zeit.*, XXXVIII., p. 343.

BOUCHUT.—On a Digestive Ferment contained in the Sap of the Fig-tree.
*Comptes Rendus*, XCI., pp. 67–8.

BUCHNER, H.—On the Experimental Production of Cattle-distemper Contagion from the Hay Fungi.
*SB. K. Bay. Akad. Wiss.*, 1880, pp. 368–413.

„ „ Experiments on the Origin of the Cattle-distemper by Inspiration. *SB. K. Bay. Akad. Wiss.*, 1880, p. 414–23.

CHAUVEAU, A.—The Causes which may produce a variation in the Results of Anthracic Inoculation of Algerian Sheep. Influence of the Quantity of the Infecting Agents. Applications to the Theory of Immunity.
*Comptes Rendus*, XC., pp. 1526–30.

COOKE, M. C.—Observations on Peziza. *Grevillea*, VIII., pp. 129–41.

„ „ Note on Mr. Ellis's Reply to Dr. Corre's Criticism of Paper on "Variability of *Sphæria quercuum* Sz."
*Grevillea*, VIII., pp. 144.

„ „ On *Hymenochæte* and its Allies. „ pp. 145–50.

FRANK, A. B.—Note on the Onion-Smut. *Bot. Centralbl.*, I., p. 186.

GREENFIELD.—*Bacterium Anthracis*. [Report to the R. Agricultural Society.]
*Quart. Journ. Micr. Sci.*, XX., pp. 374–6.

HUBERSON, G.—The Observatory of Montsouris and the Atmospheric "Dusts."
*Brebissonia*, II., pp. 145–7.

KALCHBRENNER, C.—Fungi of Australia. I. Basidiomycetes.
*Grevillea*, VIII., pp. 151–4.

LANZI, C. M.—The Fungi of the Province of Rome. Part 2. pp. 33–48. Plates 3 and 4. [Sep. repr. *Atti Accad. Pont. Nuov. Lincei*, XXXII.]

MAGNUS, P.—Remarks on A. B. Frank's Note on the Onion-Smut.
*Bot. Centralbl.*, I., pp. 348–9.

MICHELSON, P.—The Discussion on the Ætiology of *Area Celsi*.
*Arch. path. Anat. & Physiol.* (*Virchow*), LXXX., pp. 296–310.

MIQUEL, P.—Further Researches on the Organized "Dusts" of the Atmosphere. 10 figs. *Annuaire de l'Observ. de Montsouris*, 1880, pp. 386–513.

„ „ Studies on the Organized "Dusts" of the Atmosphere. [From 'Annuaire de l'Observatoire de Montsouris' for 1879.] 3 figs.
*Brebissonia*, II., pp. 147–65.

„ „ Atmospheric *Bacteria*. *Comptes Rendus*, XCI., pp. 64–7.

MUELLER, K.—*Phytoptus* on *Sedum reflexum* L. *Bot. Centralbl.*, I., pp. 349–50.

NAEGELI, C. v.—Nutrition of the Lower Fungi by Carbon and Nitrogen Compounds. *SB. K. Bay. Akad. Wiss.*, 1880, pp. 277–367.

PASTEUR, L.—Further Experiments on the "Choléra des Poules," and Immunity against it. [*Abstr.* from 'Comptes Rendus,' XC.] *Naturf.*, XIII., pp. 247–8.

PHILLIPS, W.—*Dacrymyces succineus* Fr., the Early Stage of a Peziza.
*Grevillea*, VIII., pp. 154–5.

PIM, G.— *Ramularia Cryptostegiæ*, nov. sp. „ „ p. 150.

RÁTHAY, E.—Preliminary Communication on the "Witch-broom" of the Cherry-tree, and on *Exoascus Wiesneri* Ráthay.
*Oesterr. Bot. Zeitschr.*, XXX., p. 225.

RIBBERT, H.—A Micro-parasitic Invasion of the whole Cortical Layer of the Brain. [Bacteria.] Plate X., fig. 5.
*Arch. path. Anat. & Physiol.* (*Virchow*), LXXX., pp. 505–6.

ROBSON, M. H.—The Salmon Disease and its Cause. 1 fig.
*Sci.-Gossip*, 1880, pp. 129–32.

SACCARDO, P. A.—Conspectus generum fungorum Italiæ inferiorum, nempe ad Sphæropsideas, Melanconieas et Hyphomyceteas pertinentium, systemate sporologico dispositorum. [Latin.] *Michelia*, 1880, No. 6, pp. 1–38.

„ „ Fungi Gallici lecti a cl. viris Brunaud, Letendre, Malbrache, Theny v. editi in Mycotheca Gallica C. Roumegueri. Ser II. [Latin.]
*Michelia*, 1880, No. 6, pp. 39–135.

„ „ Fungorum extra-europæorum Pugillus. [Latin.]
*Michelia*, 1880 No. 6, pp. 136–49.

„ „ Fungi Dalmatici pauci ex herb. illustr. R. de Visiani, addito uno alterove mycete ex Anglia et Pannonia. [Latin.] *Michelia*, 1880, No. 6, pp. 150–3.

„ „ Fungi Veneti novi vel critici v. Mycologiæ Venetæ addendi. Series XI. *Michelia*, 1880, No. 6, pp. 151–76.

SCHULTZE, H.—The Theories as to *Area Celsi*. Plates 4–5.
*Arch. path. Anat. & Physiol.* (*Virchow*), LXXX., pp. 193–217.

THUEMEN, F. DE.—Diagnoses to Centuries 13–15 of 'Mycotheca universalis.' (*In part.*) *Flora*, LXIII., pp. 312–22.

WHITE, F. B.—Preliminary List of the Fungi of Perthshire (*contd.*).
*Scott. Nat.*, V., pp. 320–5

Zopf, W.—On a new Method of Observing the Mechanism of the Escape of the Spores in the Ascomycetes, and on some results which have thereby been established. [From 'SB. Gesell. Naturf. Freunde,' 1880, No. 2.]
*Hedwigia*, XIX., pp. 94–9.

## Lichenes.

Almquist, E.—Lichenological Researches on the North Coast of Siberia.
*Öfvers. K. Vet.-Akad. För.*, XXXVI., No. 9, pp. 29–59.

Baglietto, F., and A. Carestia.—Account of the Lichens of Valsesia. (*In part.*) Plates 1–2. *Atti Soc. Critt. Ital.*, II., pp. 143–254.

Carestia, A.—*See* Baglietto, F.

Mueller, J.—Lichenological Contributions. XI. (*concld.*).
*Flora*, LXIII., pp. 259–68, 275–90.

Phillips, W.—British Lichens: Hints how to study them. (*In part.*) Plate 5.
*Midl. Nat.*, III., pp. 125–8, 167–72.

## Algæ.

Areschoug, J. E.—Description of a new Genus of Algæ belonging to the Laminariaceæ. [*Oxyglossum.*] *Bot. Notiser*, 1880, pp. 96–8.

Barkas, T. P.—Marine Diatomaceæ. *Engl. Mech.*, XXXI., p. 304.

Barkas, T. P., Brown, G. D., Fedarb, J., Hogg, J., Peal, C. N., and Shrubsole, W. H.—Bacillaria.
*Engl. Mech.*, XXXI., pp. 276, 304, 325–6, 356, 374, 405–6.

Brown, G. D.—*See* Barkas, T. P.

Cooke, M. C.—British Desmids. *Grevillea*, VIII., pp. 121–8.

Davis, G. E.—On some Protophytes. 2 plates. 15 pp. (8vo. Manchester, 1880.)

Fedarb, J.—Mineralized Diatoms. *Engl. Mech.*, XXXI., pp. 374–5.

" " *Bacillaria paradoxa.* " " p. 453.

" " *See* Barkas, T. P.

Findon, C. J. B.—*Bacillaria paradoxa.* 5 figs. " " pp. 452–3.

Grunow, A.—Observations on J. Brun's Diatomaceæ Flora of the Alps.
*Bot. Centralbl.*, I., pp. 248–55.

Habirshaw, F.—Bibliography of the Diatomaceæ (*contd.*).
*Journ. de Microg.*, III., pp. 497–500; IV., pp. 40–2.

Heurck, H. van.—Synopsis of the Diatomaceæ of Belgium. Fasc. I. Raphideæ. Part 1. Atlas. Plates 1–10. (8vo. Antwerp, 1880–1.)

Hogg, J.—*See* Barkas, T. P.

Kitton, F.—The Early History of the Diatomaceæ (*contd.*).
*Sci.-Gossip*, 1880, pp. 133–6.

Kjellman, F. R.—On the Alga-Vegetation of the Glacial Sea of Siberia.
*Öfvers. K. Vet.-Akad. För.*, XXXVI., No. 9, pp. 23–28.

Peal, C. N.—*See* Barkas, T. P.

Richter, P.—On the Change of Colour in some Fresh-water Algæ, especially the Oscillatorieæ. *Bot. Centralbl.*, I., pp. 605–7.

Shrubsole, W. H.—Mineralized Diatoms. *Engl. Mech.*, XXXI., p. 451.

" " *Bacillaria paradoxa.* " " p. 453.

" " *See* Barkas, T. P.

Stodder, C.—About Diatoms. *Am. Mon. Micr. Journ.*, I., pp. 113–5.

Wille, N.—Fresh-water Algæ from Nova Zembla collected by Dr. F. Kjellman in Nordenskiöld's Expedition, 1875. Plates 12–14.
*Öfvers. K. Vet.-Akad. För.*, XXXVI., No. 5, pp. 13–74.

Woronin, M.—*Vaucheria De Baryana*, n. sp. Plate 7.
*Bot. Zeit.*, XXXVIII., pp. 425–32.

Young, J.—Notes on the Occurrence of a Species of Boring Marine Alga penetrating the Shell Structure of a Species of *Productus*.
*Proc. Nat. Hist. Soc. Glasgow*, IV., pp. 77–8.

## MICROSCOPY, &c.

ADAMS, L. E.—Preserving Crustacea. *Sci.-Gossip*, 1880, p. 138.

ALBRECHT.—A simple Method for the Microscopical Examination of Blood for *Spirillum*. [*Medic.-Chir. Rundschau*, XIX., p. 508.]

AWDRY, Mrs. W.—Easy Lessons in Light. 114 pp. 43 figs. (8vo. London, 1880.)

"B. R.," "B.Sc.," CARR, E., EDMUNDS, J., GREY, W. J., and STANDAGE, H. C. —Chromatization of Light by a Microscopic Slide.
*Engl. Mech.*, XXXI., pp. 276–7, 303, 303–4, 304, 325, 354, 379, 399, 399–400, 421–2, 422, 447.

BARNARD, F.—On the Use of Carbolic Acid in Mounting Objects for the Microscope. *Sci.-Gossip*, 1880, pp. 137–8.

BIZZOZERO, G.—The Chromo-Cytometer. New instrument for determining the amount of Hæmoglobin in the Blood.
[*Med. Jahrb.*, *Wien*, 1880, pp. 251–67.]

BLACKHAM, G. E.—The Tolles-Blackham Microscope, *P. angulatum*, *Amphipleura pellucida*, &c. *Engl. Mech.*, XXXI., p. 400 [and see p. 420].

BRITTAN, W. C.—Preparing Slides. *Am. Journ. Micr.*, V., p. 139.

BUTTERWORTH, J.—Cutting and Grinding Rock Sections. 2 figs.
*Engl. Mech.*, XXXI., p. 277.

CALDERON Y ARANA.—Schneider's Polarizing Apparatus. 1 fig.
*Anal. Soc. Españ. Hist. Nat.*, IX. (*Actas*) pp. 35–8.

CARR, E.—*See* "B. R."

CERTES, A.—On the Micrographic Analysis of Water.
*Comptes Rendus*, XC., pp. 1435–7.

CLEVENGER, S. V.—Microscopic Examination of Tissues after the Administration of Mercury. (*In part.*) *Am. M. Micr. Journ.*, I., pp. 110–13.

CRUS, R.—Telescope, Microscope, and Aquarium Difficulties and Manipulation. 2 figs. *Engl. Mech.*, XXXI., p. 448.

Diatoms, Directions for Cleaning. (*In part.*)
*Am. M. Micr. Journ.*, I., pp. 107–10.

EDMUNDS, J.—*See* "B. R."

"Fellow of the R. Micr. Soc."—[Grubb's Microscope, 1 fig.; Paraboloid Diaphragms (Williams); New Formula Objective (Powell and Lealand's); "Numerical Aperture" as defined by Prof. E. Abbe.]
*Engl. Mech.*, XXXI., pp. 275–6.

" " [Opaque Illumination for the Microscope; a Correction. *Engl. Mech.*, XXXI., p. 302.

" " [Tolles's Opaque Illuminator for the Microscope; Prof. H. L. Smith's Vertical Illuminator; Experimental Demonstration of Apertures, &c.; Paraboloid Diaphragms.] *Engl. Mech.*, XXXI., pp. 324–5.

" " [Powell and Lealand's new Oil-immersion Condenser at the Quekett Club and Royal Society; New Formula Objectives; Royal Microscopical Society; 80,000 Diameters (?); Athletics of Microscopy.]
*Engl. Mech.*, XXXI., pp. 373–4.

" " [Paraboloid Diaphragms; Dr. Blackham on Microscope-stands and English and American Microscopy.]
*Engl. Mech.*, XXXI., p. 420.

FOUQUÉ, F., and A. M. LÉVY.—Micrographical Mineralogy—French Eruptive Rocks. (Ministère des Travaux publics.—Mémoires pour servir à l'explication de la Carte Géologique détaillé de la France.) 509 pp. 55 plates. (4to. Paris. 1879.)

GEORGE, G. F.—Dull Objectives. *Sci.-Gossip*, 1880, p. 159.

GIBBES, H.—On the Use of the Wenham Binocular with High Powers.
*Quart. Journ. Micr. Sci.*, XX., pp. 318–19.

GREY, W. J.—*See* "B. R."

Grubb's Microscope.—*See* "Fellow," &c., and "Observer."

HESCHL.—Contribution to the History of the Compound Microscope. Plate 18.
*Arch. Mikr. Anat.*, XVIII., pp. 391–402.

Iris Diaphragm an old invention. *Am. Journ. Micr.*, V., pp. 136–7.

Körting.—A new Microtome. (1 fig.) *Jen. Zeitschr. Naturwiss.*, VII., pp. 193–5.

Levick, J.—Pond Life: where to find *Anuræa longispina.* *Midl. Nat.*, III., pp. 166–7.

Lévy, A. M.—*See* Fouqué, F.

Medical Postal Microscopical Society. *Am. Journ. Micr.*, V., pp. 117–18.

Mees, C. L.—Blood Stains. [*Med. Herald* (*Louisville*), II., p. 89.]

Moseley, H. N.—Remarks upon some Specimens of Sections of Corals prepared by Koch's Method. *Proc. Zool. Soc. Lond.*, 1880, pp. 24–7.

„ „ Description of a new Species of Simple Coral. 2 figs. *Proc. Zool. Soc. Lond.*, 1880, pp. 41–2.

"Observer."—The Grubb Microscope-stand. *Engl. Mech.*, XXXI., p. 420.

Pelletan, J.—The Camera Lucida of Dr. J. G. Hofmann. 4 figs. *Journ. de Microg.*, III., pp. 484–5.

„ „ Gundlach's Hemispherical Immersion Condenser. 4 figs. *Journ. de Microg.*, IV., pp. 21–4.

„ „ The Camera Lucida of Dr. J. G. Hofmann. 3 figs. *Journ. de Microg.*, IV., pp. 25–6.

Pennock, E.—The Binocular Microscope. *Engl. Mech.*, XXXI., p. 304.

Peticolas, C. L.—Some new Slides from the Richmond (Virginia) Diatomaceous Earth. *Am. Journ. Micr.*, V., pp. 133–4.

Phin, J.—Micromillimetre, Micrometre, or Sixth-metre. *Am. Journ. Micr.*, V., p. 117.

Piper, R. U.—Cleaning Cover-glasses. *Am. Nat.* XIV., pp. 465.

Powell & Lealand's New Formula Objective—*See* "Fellow," &c.

Quiroga, F.—Micrographical Study of some Basalts of Ciudad-Real. Plate 3 to follow. *Anal. Soc. Españ. Hist. Nat.*, IX., pp. 161–79.

Romeo, Nelly A.—*Pleurosigma angulatum.* *Am. Journ. Micr.*, V., pp. 137–8.

Row, F.—A new Collecting Bottle. 1 fig. *Sci.-Gossip*, 1880, p. 136.

Sanio, C.—On the Preparation of a suitable Asphalt Varnish for Microscopical Slides. *Bot. Centralbl.*, I., pp. 90–1.

Seiler, C.—Microscopic Examination; Preparation of Tissues (*contd.*). [*Med. Herald* (*Louisville*), II., pp. 87–9.]

Serrano y Fatigati.—Optical Phenomena in the Field of the Microscope. *Anal. Soc. Españ. Hist. Nat.*, IX. (*Actas*), pp. 20–1.

Sharples, S. P.—Adulterations of Food. *Am. Nat.*, XIV., pp. 461–3.

Sorby, H. C.—On the Structure and Origin of Non-Calcareous Stratified Rocks. 11 figs. [Anniversary Address.] *Quart. Journ. Geol. Soc.*, XXXVI., *Proc.*, pp. 46–92.

Standage, H. C.—*See* "B. R."

Stodder, C.—Microscope-stands [Beck and Tolles]. *Engl. Mech.*, XXXI., p. 420.

Stokes, A. C.—Growing Slides. *Am. Journ. Micr.*, V., p. 139.

Suffolk, W. T.—The President's Address, 1880. [South London Microscopical and Nat. Hist. Society.] 4 pp. (8vo. London, 1880.)

Tiffany, F. B.—Microscopic Examination of the Blood in the Living Person. [Prepuce.] 2 figs. [*St. Louis Med. & Surg. Journ.*, XXXVIII., pp. 387–9; *Louisville Med. Herald*, II., p. 30.]

Waters, A. W.—Some Rocks of the Vaudois Alps studied microscopically. Plate 24. *Bull. Soc. Vaud. Sci. Nat.*, XVI., pp. 593–8.

Wenham, F. H.—Mr. Stodder and Angular Aperture. *Am. Journ. Micr.*, V., p. 137.

„ „ On an Improved Immersion-Paraboloid. 3 figs. *Am. M. Micr. Journ.*, I., pp. 101–2.

Wickersheimer's Preserving Fluid. *Entomol. Nachr.*, VI., pp. 129–32.

Williams, G.—Paraboloid Diaphragms. *Engl. Mech.*, XXXI., p. 304 [see also pp. 275–6, 325, 400, and 420].

Willis, L. M.—The Abbe-Zeiss High-angled Immersion Condenser. 2 figs. *Am. Journ. Micr.*, V., pp. 108–9.

# PROCEEDINGS OF THE SOCIETY.

Meeting of 9th June, 1880, at King's College, Strand, W.C.
Dr. R. Braithwaite, F.L.S. (Vice-President) in the Chair.

**The Minutes** of the meeting of 12th May last were read and confirmed, and were signed by the Chairman.

---

**The List of Donations** (exclusive of exchanges and reprints) received since the last meeting was submitted, and the thanks of the Society given to the donors.

| | From |
|---|---|
| Microscope ("Sketch-Model"), formerly in the possession of Mr. Edwin Quekett, one of the original members of this Society, and esteemed by him and by his brother, Professor Quekett, as an interesting example of early endeavour to improve the construction of the Microscope .. .. .. .. .. | *Mr. C. F. White.* |
| Parkes & Son's Microscope Lamp, with Cooling Evaporator .. | *Messrs. Parkes and Son.* |
| Pepper Cane, Section of .. .. .. .. .. .. .. .. .. .. | *Mr. T. Christy.* |
| *Surirella gemma* from Emden, Prussia, Bottle of .. .. .. | *Herr O. Brandt.* |
| Zoological Station of Naples—12 slides .. .. .. .. .. .. | *The Station, through Mr. A. W. Waters.* |

Mr. Crisp called special attention to the slides received from the Zoological Station at Naples, which were exhibited under Microscopes in the room (see p. 700).

---

**Mr. Crisp** exhibited and described Waechter's Trichina-Microscope (see p. 714), and Dr. Weber-Liel's Ear-Microscope (see p. 710), and described Dr. Tiffany's Prepuce-Microscope (see p. 709).

---

**Dr. Matthews** exhibited and described a new form of turntable (see p. 716).

---

**Mr. Crisp** exhibited and explained a "Micrometer-Microscope" made by M. Hartnack, a description and illustration of which will be published hereafter.

---

**Mr. Beck** said it had struck him for some time that there was a great deal of interest attached to the question of the purity of the water supply, and that the reports sent in by the inspectors were of such an uninstructive character as to be worth very little indeed to the general public, who were the persons most interested in the matter. He, therefore, thought that if the Society as a body could do something to instruct them as to what were signs of purity and what were really impurities it would be doing a very good service. He remembered that some time ago when there was a Parliamentary

Committee appointed to consider the subject, there were shown in some of the water examined some monstrous creatures which were calculated to cause alarm to any one; but the scientific evidence showed that the water was really so pure and free from sewage contamination that it did not kill the creatures which were found. He threw this out as a hint, as he believed that they ought to show that whilst they were a scientific body in the highest sense of the term, they were capable of work which would really be of great public benefit.

The Chairman said he quite agreed with Mr. Beck in his remarks, and invited the Fellows to act upon the suggestion made. He thought, however, that they must rely upon the action of the working Fellows of the Society rather than on any committee, and hoped that during the coming recess something might be done in the matter.

---

**Mr. J. W. Stephenson** read a paper "On the Visibility of Minute Objects mounted in Phosphorus, Solution of Sulphur, Bisulphide of Carbon, and other Media" (see p. 564).

Mr. Stewart said that the paper did not relate to a matter of mere optical curiosity, but to an extremely valuable means of investigation as applied to minute structure, which was brought out and rendered visible with marvellous clearness.

---

**Mr. Crisp** described and commented on the proposed process for cleaning Foraminifera suggested by Mr. K. M. Cunningham, the method recommended being electrical attraction (see p. 692), and Mr. A. A. Bragdon's suggestion of the use of glycerine and sulphocarbonate of zinc as a medium for homogeneous immersion (see p. 701).

---

**Dr. Edmunds** read a note "On a Parabolized Gas Slide," specimens of which were exhibited in the room (see p. 585).

---

**Mr. W. H. Gilburt** read a paper "On the Structure and Function of the Scale-Leaves of *Lathrea squamaria*," illustrating the subject by a number of drawings on the black-board.

The Chairman, in moving a vote of thanks to Mr. Gilburt, remarked that the curious plant which had formed the subject of his paper was not an uncommon one, and the paper showed how much interest could be got out of a common object if only it were handled by competent hands.

Mr. Stewart thought it would be interesting to test the nature of the fluid secretion which Mr. Gilburt had mentioned, in order to see if it were at all the same as that in the *Drosera* and other carnivorous plants.

---

**Mr. Crisp** exhibited and described Zeiss's micro-spectroscope (see p. 703), and Hartnack's polarizing apparatus.

---

**Mr. Woodall** gave a résumé of his paper "On the Interference-Phenomena produced by Luminous Points."

---

**Mr. Crisp** announced that it had been decided by the Council that the books in the Society's library should be allowed to be circulated amongst the Fellows under regulations which would be announced as soon as the Assistant-Secretary had completed the catalogue of the library which he had in hand.

---

**Professor Rogers's** paper "On Tolles's Illuminator for High Powers" was read.

---

**Professor Abbe's** paper "On the Function of Aperture in Microscopic Vision" was taken as read.

Mr. Crisp read a part of a letter from the author, in which he said: "Having been often blamed for obscurity, I resolved to explain my opinions in such a way now that they cannot fail to be understood." The paper would probably exceed 150 pages of the Journal, and the Council had therefore decided to print it as a separate volume.

---

**Mr. Crisp** said that it had been represented to him that some of the Fellows would like that the larger part of the Journal should consist of "Microscopy," i. e. matter relating to the Microscope as an instrument, its modifications, improvements, &c. As every existing source outside the Society was already made use of for "microscopical" notes, one of two things must have happened (remembering that the suggestion came from within and not outside the Society)—either communications from Fellows intended for the Journal had accidentally failed to reach him from some unexplained cause, or it was not sufficiently understood by the Fellows that the "Microscopy" portion of the Record was available for communications which might not be so appropriately printed as a formal "paper" in the Transactions.

In addition it must be remembered that all tastes had to be consulted in the compilation of the Journal (a point which he had kept prominently in mind), and it was clear that there was a considerable body of the Fellows who took only a secondary interest in the Microscope from an instrumental point of view, and who were more especially concerned with the subjects which required the aid of the Microscope for their investigation.

A second point which he wished to refer to was, that it was not to be supposed that everything mentioned in the Journal was intended to be thereby certified as "new." Substantially he had discontinued the use of that word altogether in relation to microscopical matters on account of the irritation it seemed to produce, but still there was never a Journal issued that he did not receive more than one letter pointing out that what was described had "been done before." *

A Special General Meeting was then held pursuant to the notice given at the last meeting (see p. 559).

Dr. Gray moved and Mr. Michael seconded the following resolution, which was carried unanimously:—

That the 6th Bye-law be cancelled, and the following substituted in lieu thereof.

"6. Every Fellow on his election shall pay an entrance fee of two guineas.

"6a. The Annual Subscription to be paid by the Fellows shall be two guineas, which shall become due in advance on the 1st January in every year. Fellows elected in any of the months subsequent to June shall pay one-half only of the subscription for the current year."

The following Objects, Apparatus, &c., were exhibited:—

Mr. T. Christy:—Section of Pepper Cane.

Mr. Crisp:—Hartnack's Micrometer-Microscope; Waechter's Trichina-Microscope (see p. 714); Weber-Liel's Ear-Microscope (see p. 710); Hartnack's Polarizing Apparatus; Zeiss's Micro-Spectroscope (see p. 703).

Mr. O. Brandt:—Twelve slides by R. Getschmann, of Berlin (arranged Insect scales, &c.).

Mr. Gilburt:—Six sections of *Lathrea squamaria*, illustrating his paper.

Dr. Matthews:—Improved Turntable (see p. 716).

Messrs. Parkes and Son:—Microscope Lamp (see p. 528).

Mr. J. W. Stephenson:—*Amphipleura pellucida*—in sulphur dissolved in bisulphide of carbon; *Pleurosigma elongatum*—in phosphorus dissolved in bisulphide of carbon; *Pleurosigma formosum*—in bisulphide of carbon alone. (All with Catoptric Immersion Illuminator.)

Mr. C. F. White:—Microscope (see p. 733).

Zoological Station at Naples:—Twelve slides, viz.: *Amphioxus lanceolatus* Yarr.; *Ascetta blanca* H.; *Asteracanthion glacialis* O. F. Müller—Larva; *Asterias glacialis* O. F. M.—Gastrula; ditto—Formation of the Mesoderm; *Echinocardium cordatum* Gray—Larva; *Pyrosoma elegans* Les.—Young Colony; *Pseudodidemnum Listerianum*—Ova with embryo; *Toxopneustes brevispinosus* J. Müller—Larva, 3rd, 5th, and 15th day; *Stichopus regalis* Cuv.—Ovary.

* This is irrespective of the descriptions of Microscopes previously figured in foreign journals, but which not having hitherto appeared in any English publication, are now figured and described in the Journal so as to make the English Record as complete as possible.

BI-MONTHLY.

Vol. III. No. 5.] OCTOBER, 1880. [To Non-Fellows, Price 4s.

# JOURNAL

OF THE

# ROYAL MICROSCOPICAL SOCIETY;

CONTAINING ITS TRANSACTIONS AND PROCEEDINGS,

AND A RECORD OF CURRENT RESEARCHES RELATING TO

**INVERTEBRATA, CRYPTOGAMIA, MICROSCOPY, &c.**

*Edited, under the direction of the Publication Committee, by*

FRANK CRISP, LL.B., B.A., F.L.S.,

*One of the Secretaries of the Society;*

WITH THE ASSISTANCE OF

A. W. BENNETT, M.A., B.Sc., *Lecturer on Botany at St. Thomas's Hospital,*

F. JEFFREY BELL, M.A., *Professor of Comparative Anatomy in King's College,*

AND

S. O. RIDLEY, B.A., F.L.S., *Of the British Museum,*

FELLOWS OF THE SOCIETY.

WILLIAMS & NORGATE,

LONDON AND EDINBURGH.

THE JOURNAL is published at the end of the first week of the month.

RINTED BY WM. CLOWES AND SONS, LIMITED,] [STAMFORD STREET AND CHARING CROSS.

# JOURNAL

OF THE

# ROYAL MICROSCOPICAL SOCIETY.

VOL. III. No. 5.

## CONTENTS.

Record of Current Researches, &c.—*continued.*

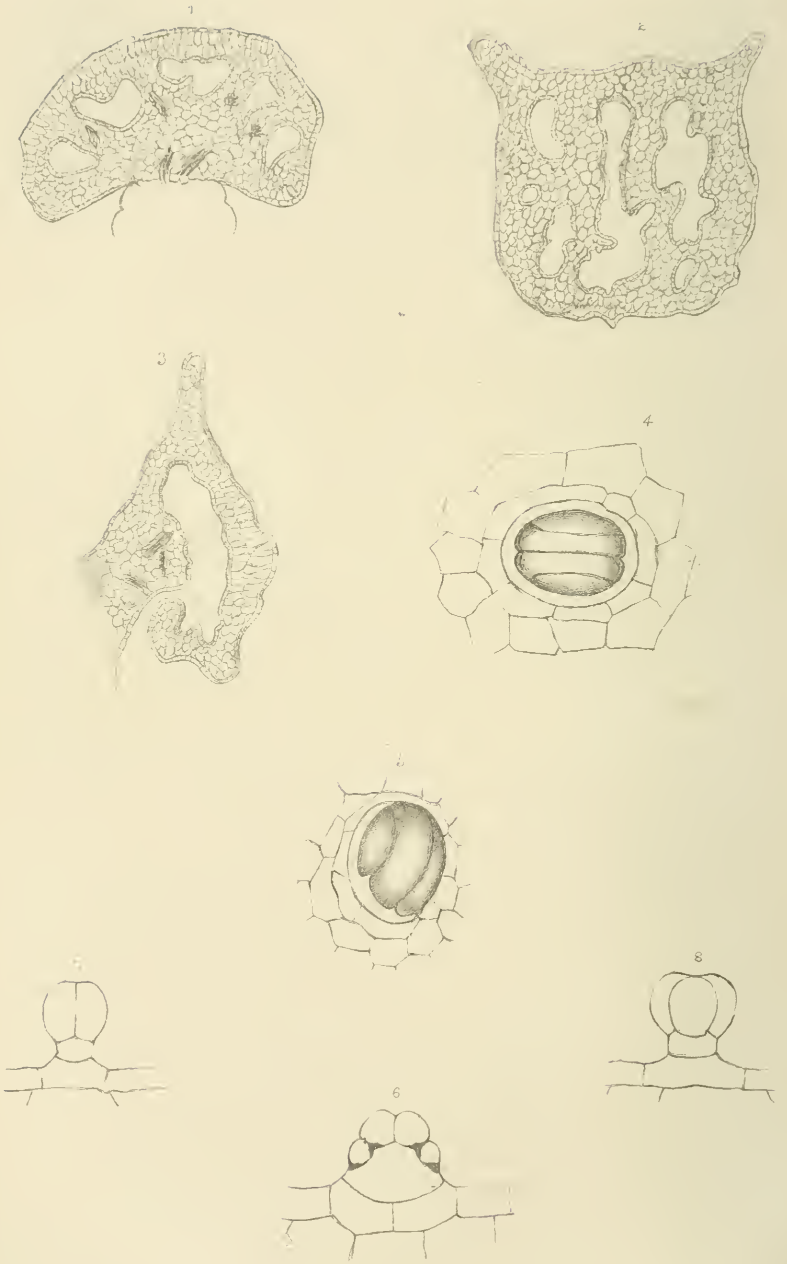


## Botany.

Record of Current Researches, &c.—*continued.*



Microscopy, &c.




West, Newman & Co. sc.

Scale-leaves of Lathraea squamaria

# JOURNAL

OF THE

# ROYAL MICROSCOPICAL SOCIETY.

OCTOBER, 1880.


## TRANSACTIONS OF THE SOCIETY.

### XX.—*On the Structure and Function of the Scale-Leaves of Lathrea squamaria.* By W. H. GILBURT, F.R.M.S.

(*Read 9th June*, 1880.)

PLATE XVII.

BENTHAM, in describing the underground portion of this remarkable plant, says: "Rootstock fleshy and creeping, covered with close-set, short, thick, fleshy scales." * Syme and Lankester first describe it as having subterranean stems, and then go on to say, "Rootstock branched, giving off slender fibres which attach themselves by minute tubercles to the plant on which it grows;" and further on, "The common name of this plant was given to it from a supposed resemblance of the scaly roots to a human tooth." †

That the term "rootstock" is here incorrectly applied will, I think, be at once apparent, for the following reasons:—(*a*) That the flowering stem is a direct continuation of axis of the plant; (*b*) that the scales with which the underground portions are furnished arise, as do all leaves, in strictly acropetal order; (*c*) and that the branches are produced from buds arising in the axils of these scales. We must therefore regard it not as a rootstock, but as an underground stem; and the scales, as leaves which have undergone modification.

The description given above conveys all that need be said of

EXPLANATION OF PLATE XVII.

FIGS. 1–3.—Sections of scale-leaves. 1. Transverse. 2. Tangential. 3. Vertical and radial to the stem.

„ 4–6.—Sessile surface glands. 4. In plan. 5. Perspective. 6. Optical section showing large basal cell, and thickening of cap-cell walls in angles.

„ 7, 8.—Pedicellate glands.

Figs. 1–3 × 8; 4–8 × 225.

* 'Handbook of British Flora,' vol. ii. p. 601.

† 'English Botany,' vol. vi. pp. 189–90.

their outward aspect; but sections of them exhibit a far more complicated structure than their outward form would lead us to expect. Figs. 1–3 represent sections in as many directions, No. 1 being transverse, 2 tangential, and 3 longitudinal and radial with regard to the stem.

The sections show that these organs are so developed as to enclose a number of chambers, having communication externally at their base. These chambers are produced by the early, unequal, and excessive development of what is morphologically the under side of the lamella of the leaf, the epidermis being continuous over their entire inner surface. Their number and form is very variable, and they frequently communicate with each other.

The whole of the inner surface of these chambers is literally crowded with glands, of which there are two forms,—a sessile gland, three views of which are shown in Figs. 4–6, and a pedicellate gland, Figs. 7, 8. The first form is composed of four cap-cells arranged parallel to each other, and a large basal cell, which appears as an annulus round the cap-cells, when the gland is looked at in plan or perspective, Figs. 4, 5; Fig. 6 being an optical section, showing peculiar thickenings of the walls of the cap-cells at four out of the five angles formed by their union with the basal cell. The lower wall of the latter, where it is in contact with the deeper cells of the leaf, exhibits a large number of simple pits, rendering it almost sieve-like in appearance. The other form of gland has a pedicel usually consisting of a single cell cut off from the epidermal cell from which it originated by a septum, and a glandular head of two or four cells, the cell plates which form them being always laid down vertically and at right angles to each other. Occasionally one of these glands may be found having a pedicel of two, three, or four cells in vertical series, while others have a head of only three cells, the division of one of the primary daughter-cells being suppressed.

Both kinds of glands are filled with a colourless, hyaline protoplasm, in which usually a few granules are included, frequently exhibiting vigorous Brownian movement.

On the surface of both forms of glands in the older scale-leaves a large number of rigid, rod-like filaments are to be seen standing at right angles to their surfaces, the nature of which I have not been able to determine. They do not appear to be protoplasmic in their character, as they do not shrink under the application of alcohol, and are not continuous with the cell-contents. In young leaves they are absent. In the older leaves the glands are also always found surrounded with an accumulation of flocculent matter.

The vascular system of the leaves also requires notice. The common bundles, upon entering the leaves, divide at once, their primary branches passing up between the chambers, where they again divide and subdivide, their ultimate divisions being composed of spiral cells only in a single series. These vascular twigs are very numerous, and only separated from the epidermis and glands of the chambers by a single layer of cells, their course being parallel with that of the chamber-walls.

Bearing in mind the conditions under which *Lathrea* lives, viz. always buried beneath the surface of the ground, often somewhat deeply, the question naturally suggested by an examination of these structures is, What is their function? for it cannot be supposed that organs so highly specialized should exist and yet serve no important purpose in the economy of the plant.

If a tangential section of a leaf of a plant growing under normal conditions be removed, it will be found that all the chambers are filled with a fluid somewhat turbid in appearance and having a most decided acid reaction; we may therefore conclude that at least these glands serve the purpose of secretion, the fluid secreted being discharged outwardly. That this takes place somewhat abundantly may be inferred from the fact that in the bank from which I have taken my material, and which is composed of a light friable loam, the soil immediately surrounding the *Lathrea* was saturated with moisture, while all beside could be crumbled apart with the fingers.

The probability that they possessed absorbing powers also suggested itself, and a large number of experiments have been made to determine it, adopting the methods employed by Mr. Darwin with *Utricularia*, &c.

Thus five tangential sections were cut from the same leaf. They were cut as thick as could be well examined under a $\frac{1}{4}$-inch objective, so as to have as many glands under observation as possible. The sections were first placed under thin covers in distilled water and examined carefully, when all the glands were seen to present their normal appearance. The distilled water was then withdrawn, and under four of the covers a solution of carbonate of ammonia in the proportion of 1 to 400 was run in, and under the other a 1 per cent. solution of cane sugar.

After two hours they were examined, and no change was visible; after three and a half hours a few of the pedicellate glands showed decided contraction of the protoplasm and a slight increase of granulation; after twelve hours all these glands showed contraction of their contents, more or less; and in twenty-four hours, in all, the protoplasm was greatly contracted and coarsely granular; while the section in the sugar solution had only a very few of the glands slightly affected. The sessile surface glands and the cells of the epidermis remained unaltered, save by the general darkening of their contents which invariably takes place when the plant is either placed in water or exposed to air. Repeating these experiments with other sets of sections, the results were sometimes less decided; some of the glands treated with the carbonate remaining unaffected, while a considerable number of those in the sugar solution showed contraction.

Ammonia-nitrate and phosphate were also employed, of several strengths, from 1 to $\frac{1}{8}$ per cent., using control solutions of cane sugar or gum-arabic, and occasionally distilled water only.

With ammonia-nitrate the results were altogether negative, a few of the glands only being affected, and about equally in all the sections both in the nitrate and control solutions.

Ammonia-phosphate in a 1 per cent. solution gave very decided results. Eight sections were placed under covers and examined to see that the glands were in their normal condition. Six of them were then irrigated with the ammonia-phosphate and two with a 1 per cent. solution of sugar.

In two hours a slight increase of granulation was observed in the pedicellated glands of all the sections in the ammonia-phosphate solution.

In four hours the protoplasm was slightly shrunken and still more granular.

In twelve hours the above features were very decided, and the protoplasm much darker in the pedicellated glands than elsewhere.

In twenty-four hours the protoplasm was so darkened as to be quite opaque.

In none of the surface glands did I find the least alteration.

The sections in sugar solution were nearly unaltered, only very few of the pedicellated glands but retained their normal appearance.

Other sets of sections were placed in solutions in the proportion of 1 to 200, 400, 800; and in each case the results seemed to point in the same direction, though the changes were neither so rapid nor decided. In sections placed in a 1 per cent. solution of gum-arabic, about half the pedicellated glands showed contraction and granulation, while others placed in water, putrid with decaying vegetation, remained quite unaltered after twenty-four hours. Sections placed in distilled water, after being first washed in it, preserved their normal appearance at the end of thirty-six hours; while others placed in it direct from the razor had about half their glands contracted after the lapse of twenty-four hours.

These facts, if not amounting to an absolute demonstration of the absorbing function of the pedicellate glands, yet furnish strong presumptive evidence in favour of it.

We may also infer that seeing the fluid which fills the leaf chambers is acid in character, it must be secreted by the leaf; and as the sessile surface glands in all the experiments made, remained absolutely unaltered, we may conclude that it is by them that the function is performed. In all probability these functions, viz.

secretion and absorption, take place alternately, as in other plants where similar organs are found, and similar secretions are poured out.

That the purpose served by these organs is of advantage to the plant cannot for a moment be doubted, and that it should be in any other way than nutrition is difficult to suppose; and if this be so, we must conclude that it is the decaying organic matter in the soil which is appropriated by the plant, being dissolved by the acid solution so copiously poured out, as inorganic substances could not be assimilated in the absence of light.

Of course if this be the case, *Lathrea* must in future be regarded as but partially parasitic—a view which was, I believe, held by Henfrey, on account of the fact that it is often found possessing roots. That *Lathrea* does sometimes develop adventitious roots abundantly is without doubt, I having a longitudinal section of the end of a secondary stem about half an inch in length, in which eleven such roots are shown in section. Whether these roots are to be regarded as such, functionally, or only as organs of attachment to the host, I am not quite prepared to say. In a portion of a plant which I attempted to grow in a garden pot independent of a host—and in which some amount of growth took place—a large number of thin and delicate roots were developed from the internodes of the stem nearest the summit. The plant, however, perished during the severe frosts of last winter.

## XXI.—*On Daylight Illumination with the Plane Mirror.* An Appendix to Part I. of the "Theory of Illuminating Apparatus."*

By the late Dr. H. E. Fripp, Ex.-off. F.R.M.S.

(*Read* 14*th January*, 1880.)

In my paper on the theory of illuminating apparatus, published in the last volume of the Journal, I referred at some length to a doctrine, which, being well accredited by scientific men abroad, did not occur to me as a possible stumbling-block to the acceptance of arguments based thereon, until I learned how much it was at variance with the teaching and belief of microscopists in this country. It was, namely, contended that an object placed on the stage of the Microscope is always and necessarily illumined by a *converging* pencil when daylight is reflected upon it from the plane mirror. In English handbooks of the Microscope it is, on the contrary, assumed without question that the illuminating pencil is derived from a *parallel* beam of rays incident on the mirror whether plane or concave. Now since the conclusions, theoretical and practical, deduced from such widely opposed premises cannot but be as contradictory as the premises themselves, while, moreover, they cannot both be true, it is desirable as well as important, in a scientific point of view, that these antagonistic beliefs should be brought to the final arbitrement of fact. The question is one which optical science is perfectly competent to determine, proof or disproof of either proposition being readily drawn from consideration of first principles or from experimental tests. In the hope that a more explicit statement of the rationale of "converging light" may bring it more fairly under the notice of those who may be disposed to give this doctrine due attention, I now present a short summary of the grounds upon which it rests.

The transference of light, *in an optical sense*, from one point or surface to another is effected either by reflection or refraction. And in discussing the function of the mirror our sole appeal is to the law of reflection, just as the law of refraction would be appealed to if the action of the various lenses of an illuminator were in question. But in connection with this transference of light by means of reflector or refractor an interesting problem occurs in estimating the illuminating effect of the different surfaces which consecutively take the place of the primary light source, ending with the last reflecting or refracting surface brought into action (as in compound illuminators). All that we know of the property of light in rendering visible to the eye material particles upon which rays impinge in such direction as to enter the pupil when reflected, and so for the

* See this Journal, ii. (1879) p. 503.

time render them virtually self-luminous, strengthens the proposition that the illuminating power of any light-reflecting apparatus is measured by the number and direction of rays which fall upon the object (placed on the Microscope stage) from the mirror or lens surface next to it: and that the specific intensity of the light can never be greater than that of the primary light source. This problem is reduced to its simplest possible form in the case of the plane mirror. We have but to remember that each constituent point of its surface is independent of every adjacent point, so far as incidence and reflection of the light rays are concerned. And it remains only to discuss the right application of the law of reflection under given circumstances, and to note that the physical constitution of ordinary daylight enables it to fulfil the conditions required for illumination with the plane mirror.

It is not denied that out of a countless number of rays impinging from all sides on the surface of a mirror freely exposed to daylight, and consequently reflecting them on all sides according to their several lines of incidence, the larger proportion falls with parallel incidence. But it is contended that parallel beams are reflected as such, and—for that very reason—their component rays do not touch the object, but pass by and outside of it. It is further contended that every ray which does reach the object must approach from without in a direction determined by the position of the point or surface-element of the mirror where the reflection takes place; that is to say, on the relation of this position to the object on one side and the light source on the other.

The demonstration of these points is offered in the accompanying diagrams.

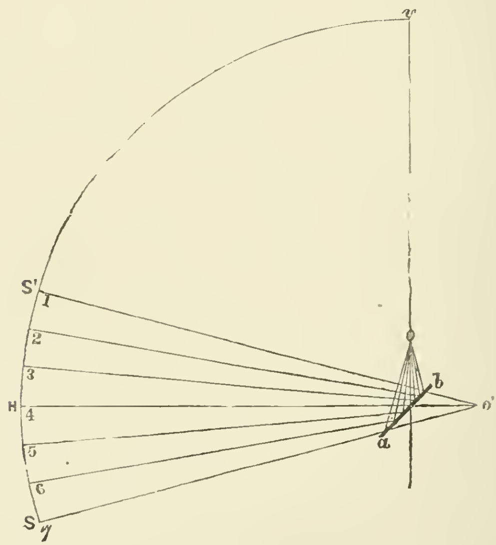
It will be granted that *obliquity of incidence* must always give rise to *obliquity of reflection.*

Further, it will appear from consideration of the relative position of object, mirror, and light source (due to mechanical arrangement of the Microscope), that light *must always fall obliquely on the mirror* in order to strike the object, whatever be the size or inclination of the mirror.

The problem of converging illumination is therefore demonstrated when it is shown that rays incident upon constituent surface elements of the mirror outside of its centre *do incline*, after reflection, towards an axial line above that centre. This axial line coincides with the axis of the Microscope when the mirror is set for "central illumination," but when the mirror is moved into position for oblique illumination, the axial line is also oblique and coincident with an imaginary line drawn from centre of the mirror to the several points of the object on which illuminating pencils fall. But those rays alone will reach the object which fall with the necessary incidence and reflection.

To find this necessary direction I construct a diagram, in which lines are drawn from the object to opposite points of the mirror (those which indicate the extreme angular magnitude of pencil allowed by size and distance of the mirror from the object and its inclination to the axis of the Microscope), and project according to the law of reflection lines outward into space which indicate the exact arc of sky from which the light *should come.* Fig. 66 shows the lines 1 and 7 including an angle of 30°. If nothing intervene, the light of that sky surface must fall upon the mirror and be reflected on O. The intermediate rays 2, 3, 4, 5, 6, have each their particular angle of incidence and reflection, and form the *converging illuminating pencil,* or rather skeleton outline of it, since the interspaces are filled by rays not indicated. (N.B. The diagram shows and corrects the mistake of drawing in Fig. 3, p. 518, vol. ii.). The magnitude of pencil is of course primarily dependent upon the presence of adequate light surface, but its extreme limit depends upon the size of the mirror and its nearness to the object.

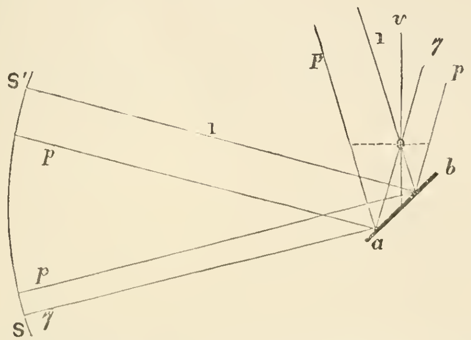
Fig. 66.




*a b*, mirror: diameter = $2\frac{1}{4}$ inch; *a o b*, angle of pencil = 30°; *o*, object; S H S', arc of sky surface which delivers light on *a b*, subtending angle of 30°; 1, 2, 3, 4, 5, 6, 7, rays falling with variously oblique incidence on mirror; *v o*, vertical line = axis of Microscope; H *o'*, horizon line; S *o'* S', angle of 30°.

In the next place, it is to be observed that parallel beams incident in the direction of the extreme outside rays of the illuminating pencil drawn in Fig. 66 and occupying the whole surface of the mirror (Fig. 67, 1 *p*, 7 *p*), touch the object by their outside ray only, the remainder passing by on either side. And, further, that a parallel beam incident also upon the whole mirror surface, but at right angles to the axis of the Microscope, illumines the object by

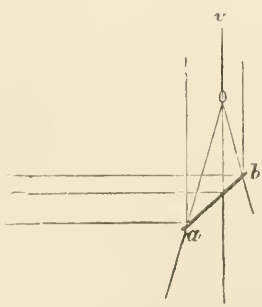
Fig. 67.




*p p*, two rays drawn parallel with 1 and 7 respectively. The parallel beams 1 *p* and *p* 7 occupy the mirror surface, but instead of being reflected on the object, fall outside of it, excepting the rays 1 and 7.

its axial ray alone, as shown in Fig. 68. So also if each of the intervening lines (2, 3, 4, 5, 6, Fig. 66) represented the course of as many parallel beams occupying the whole mirror surface with the

Fig. 68.




Parallel beam incident on mirror at angle of 45° to axis of Microscope. Its axial ray alone falls on the object. With different inclination the central ray falls away from the object, and the illumination becomes oblique: namely, from some point of mirror surface more or less distant from its centre. This obliquity of direction does not indicate convergence of light, as it comes from one side only at a time.

incidence belonging to each line respectively, it is manifest that the rays would fall on different surface elements of the mirror, and remaining parallel after reflection, fail to strike the object. In fact, while those rays which *do* fall with such incidence as to be reflected on the object, form a converging pencil of given angular magnitude (e. g. 30° in Fig. 66), the several bundles of *parallel* rays falling from the same area of light source would after reflection occupy a space at the plane of the object (see dotted lines in Fig. 67) half as large again as the mirror; scarcely a suitable illumination for a microscopic object!

Lastly, the illuminating power of diverging rays, supposing them to proceed from a single point of light source and spread

FIG. 69.

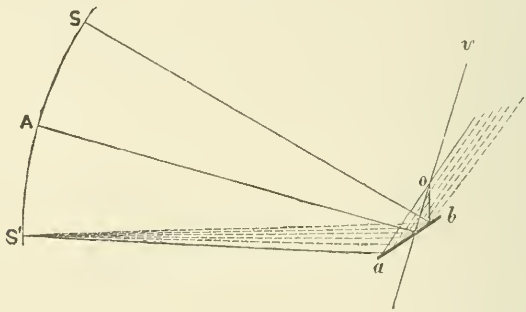
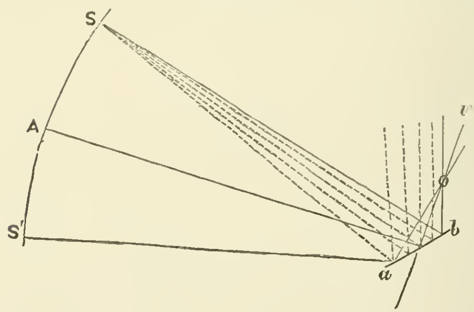



FIG. 70.




*v o*, axis of Microscope, the instrument being reclined to get the whole pencil above line of horizon; *a b*, mirror inclined at 45°; *a o b*, angle of illuminating pencil = 30°, subtended by S S′, arc of sky; A, axis of illuminating pencil reflected on *o*, object; S *b* and S′ *a*, outlines of cone reflected on object, *o*.

The dotted lines in both diagrams show that no other rays but S *b* and S′ *a* touch the object, as the other diverging rays from the points S and S′ falling with greater or less obliquity on the mirror surface, are reflected in directions more and more remote from the object.

over the mirror surface, as in Figs. 69 and 70, is too slight and moreover too scattered to add anything to the total effect.

But it may be (perhaps fairly) objected that diagrams, though useful in illustration, prove nothing unless they themselves are proved; or that they mislead when employed to demonstrate phenomena in which the effects of distance which cannot be represented are main elements of the question; as, for example, where it is asserted that sky and cloud light must by reason of their distance fall with parallel incidence of rays. In the discussion of such a doctrine it is pertinent to inquire what that distance is, and what relation it bears to the extent of luminous surface which can be brought into play. In regard to the parallelism of the direct solar rays there is of course no question. But the parallelism of that portion of solar light which goes to form the firmament in our own higher atmosphere is so completely broken up by repeated refraction and reflection amongst the subtle particles of this higher atmosphere, that the rays which constitute our daylight fall from every point of the visible heavens (though with greatly diminished intensity). That is to say, we have at disposal a light source extending over 180°, while the sun itself extends over a visual angle of but half a degree! Being thus surrounded by an illimitable and self-luminous expanse of ether undulations, the question is no longer of parallel rays only, but of light emanating from an outer circle above the earth upon every point of the earth's surface. And a mirror exposed to such a luminous atmosphere must both receive and reflect from all sides, and upon all sides. If, however, it be placed under the stage of a Microscope, all vertical light is intercepted, and there remains nothing but the oblique incidence before referred to as the starting-point of the theory of illumination by converging light. But once brought to this point by the consideration of general principles, we are easily carried on by appeal to the law of reflection, in the demonstration of which a geometric diagram stands as rightful evidence, and, as it seems to me at least, affords indisputable proof that the doctrine of converging light truly applies to the pencil by which the Microscope object is illumined.

The circumstances attending illumination by cloud-reflected light differ greatly in detail, but not at all in principle. That portion of solar rays which strikes upon and is reflected from the cloud vapour close to the earth (in comparison with firmament or sky light) retains, after reflection, nearly the same mixture of colour as produces white light. But its superior illuminating power is due probably to the *near* distance from the earth at which the refraction and reflection of the solar rays begin, the reflected light having but a short distance to travel. Another result of this proximity is that the illumined portion of a single cloud may cover a considerable arc of sky, 5° to 20° or more. And since this luminous expanse is frequently but a mile or less from the earth, rays from extreme points of the cloud must fall with obliquity of incidence upon the mirror. It must be borne in mind, however, that the direction of the reflected rays is influenced by mass and shape of the cloud as a whole, and that its constituent vapour particles do not present a continuous reflecting surface. The numerous minute fields of light and shade which may be observed within a comparatively circumscribed portion of cloud surface abundantly prove the actual inequality of reflection.

From the diagrams it may be gathered that one ray only out of each parallel beam occupying the mirror surface with a given degree of incidence actually falls on the object. And, further, that the rays which collectively form the illuminating pencil are singled out, so to speak, by their fulfilment of the necessary condition of converging incidence from a large area of light source. A whole cloud or pile of clouds may in this way be utilized, though the general surface is so unequally bright that the darker portion will frequently reduce the effect of the brighter to below the average intensity of sky light around the cloud. Hence the concave mirror is preferred to the plane, because, *acting on a different principle*, it collects the relatively small but bright surface of sunlit cloud without diluting its intensity by including the larger darker portion. But under ordinary circumstances of sky light illumination, the convergence of light upon the plane mirror is not only a necessary consequence of optical law, but also the necessary condition of an *adequate* illumination. And it follows that the size of the mirror and its nearness to the stage are important points in the design of a Microscope, and equally requiring attention in the *practice* as in the theory of illumination.

It has been already noted that a cloud surface is not continuous, like a mirror surface, and that its shape greatly influences the direction of reflected rays. Cloud light is, in fact, self-luminous in the same sense that the light of the firmament is; that is to say, the solar rays, falling on the cloud, are refracted and reflected and dispersed amongst its own vapour particles. Consequently the parallel incidence of solar rays by no means conditions parallelism or uniformity of the reflected rays. This character of self-luminousness may be contrasted with reflection pure and simple, as, for example, the dazzling glare of a window-pane upon which the sun shines. Nobody would interpret the reflection from a smooth glass surface otherwise than as a simple transference of the sun's light in a new direction, nothing else being changed. The radiation of sun rays is simply *continued* from the surface (not self-luminous substance) of the window-pane. The cloud-reflected light is, on the other hand, a residual effect, after absorption, refraction, and dispersion of the original light rays have been carried on in the intervening cloud matter to such an extent as to lower the specific intensity of the reflected light beyond calculation. It cannot therefore be inferred from the parallelism of the solar rays that cloud light falls with parallel incidence, as may be affirmed in the case of the window-pane which reflects direct sunlight. Nor can the distance of the cloud be accepted as a sufficient cause of parallel incidence, considering its many degrees of expanse, and its actual nearness to the earth. On the contrary, it is self-evident that the *different intensity* of light reflected from a cloud at, say, *half* a mile or *three* miles distance, and its *different angular magnitude* at those distances, are infinitely more important elements in the calculation of illuminating effect than the hypothesis of parallel incidence. In fact, the inconstant distance of the cloud is in itself a practical refutation of the idea that such a cloud surface has a constant illuminating power or conditions an invariably parallel incidence of reflected rays. Is it possible to believe, for instance, that from the widely spread extremities of a sunlit cloud subtending perhaps 20° of sky arc, and distant perhaps less than a mile, none but parallel rays shall fall on the mirror? Or—taking the meaning of a parallel beam of light to be that its dimensions are the same throughout its course—is it possible to accept the notion suggested by sundry diagrams in our handbooks that two inches of sky or cloud light are all that nature offers for the illumination of microscopic objects, and all that the plane or concave mirror is capable of reflecting?

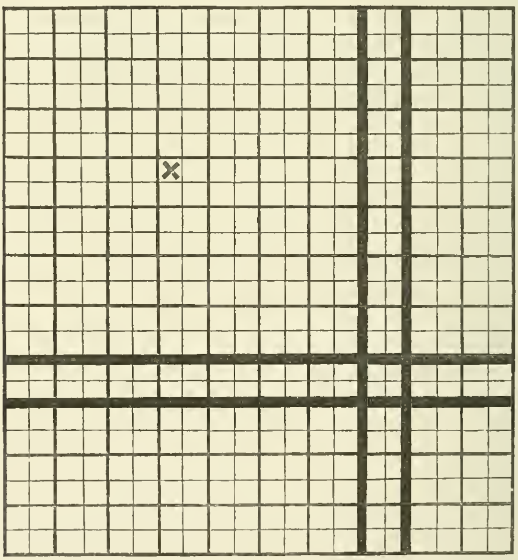
## XXII.—*On an Improved Finder.* By W. Webb.

(*Read 14th April*, 1880.)

The finder which I bring before the Society this evening consists of a square having sides of $\frac{3}{4}$ inch, and divided into 22,500 smaller squares with sides the $\frac{1}{200}$ of an inch (enclosing a space therefore equal to the $\frac{1}{40000}$ of an inch), being 20,000 more squares than the Maltwood finder, which is an inch square. The lines are ruled by a diamond upon the under side of the thin cover-glass (for better use with higher powers), and are filled in with black, the field being transparent.

One square of the Maltwood finder more than covers the field with a $\frac{1}{4}$-inch objective and A eye-piece, all the corners of the squares being out of the field; but in the new finder there are sixteen squares in the same space as one in the other.

Fig. 71.



With some of the higher powers, it is not incorrect to say that it is absolutely impossible to use the ordinary finder, because (1) being a photograph an inch on each side, it is necessarily so very coarse that when used with the high powers the image as a whole is destroyed in consequence of the separation of its component grains of silver; and (2) all specific trace of locality is absolutely lost by the great size of the squares.

To number the squares from 1 to 22,500 would require more than 100,000 figures, which renders numbering impossible; the squares are therefore plotted in blocks of 100, the boundary lines of each block of 100 squares being cut deeper, broader, and blacker than the inner ones (excepting four lines which I will describe presently), each block consisting of ten rows of squares, and each row containing ten squares. Each block of 100 squares is intersected vertically and horizontally at its fifth divisions by lines less black than those forming the boundaries of the blocks of 100 squares, but still appreciably blacker and broader than the inner lines, thus subdividing the blocks into four minor ones, each having five rows with five squares in each row, the clear distinction between the three kinds of lines commanding ready and unmistakable recognition.

To reduce the finder to its greatest simplicity in working over the three-quarters of an inch, I have introduced the four special lines above referred to, they being broader than all the others, and two of them embracing two sides of every eighth block of 100 squares from the top to the bottom of the finder, and the other two lines embracing two sides of every eighth block of 100 squares from the left to the right, the four lines thus forming the boundaries of the *central block* of 100 squares, and the intersection of the two lines which divide that block into smaller blocks of 25 squares is the central point of the finder, from which the eye has only to traverse through 75 squares vertically or horizontally to locate any square wanted

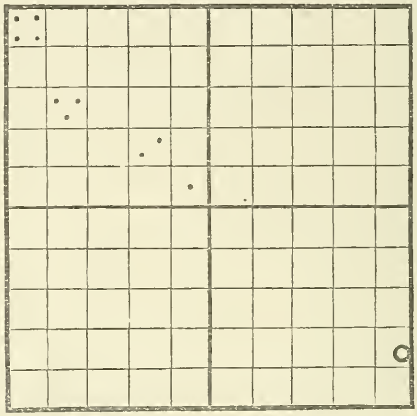
Fig. 71 represents a little more than the top left-hand quarter of the finder (the finest divisions not being however shown). It exhibits the central intersecting point of the finder, giving outside the broad lines 7 blocks of 100 squares each vertically and 7 horizontally.

Fig. 72 is an enlarged view of one of the blocks of 100 squares, with the addition of the finest lines forming those squares.

It will be readily seen, by looking at these two figures, that from the centre of the finder the whole of the 22,500 squares can be easily found by traversing at the very most 75 small squares from the centre, with the same ease and certainty as the eye traverses the long and short lines of the eye-piece micrometer, the breadth of the line in the finder being as easily distinguishable as the length in the eye-piece micrometer. The square having one dot in Fig. 72, (assuming that figure to show the central block of the finder), would be one square on the *left* of and *above* the centre, to be marked "1 l. a."; the square with two dots would be the second square horizontally and vertically to the *left* of and *above* the centre, to be marked "2 h. 2 v. l. a."; the square with three dots would be the fourth horizontally and the third vertically, to be marked

"4 h. 3 v. l. a."; and the corner square with four dots would be the fifth horizontally and fifth vertically, to be marked "5 h. 5 v. l. a." All the above-mentioned markings apply to the other three quarters of the central block, with the exception that the left above becomes

Fig. 72.



left below, or right above, or right below, of course always counting from the centre; for instance, the square marked with a O near the lower right-hand corner being the fifth horizontally and fourth vertically to the *right* and *below* the centre, to be marked "5 h. 4 v. r. b."

Having thus explained the reading of the central block, we may take the one marked × in Fig. 71, which we will now assume Fig. 72 to represent, the small square with three dots would be the 44th horizontally and 43rd vertically, or, 44 h. 43 v. l. a.

The above expressions might be simplified, as Mr. Crisp has suggested to me, into $\frac{5\,l}{5}$, $\frac{4}{5\,r}$, and $\frac{43\,l}{44}$, the numerator of the fraction always representing the vertical lines, and the denominator the horizontal ones, and $l$ and $r$ being placed in the upper or lower part of the fraction, according as the upper or lower, right or left, quadrant of the finder is intended.

Traversing the finder in any direction from the centre, one can go through only seven blocks and a half—being in all only seventy-five squares. After counting the squares once or twice, it is wonderful how rapidly the figures designating the squares are arrived at; and if the foregoing description be clearly understood the process is as short, simple, and certain as it can possibly be without numbered squares.

It is not uncommonly supposed that it is impossible to use a finder unless with a movable stage and a stop, but in the absence of these it is simply necessary to place the thumb, or a finger of the *right hand,* upon the slip of glass carrying the object (when it is in the centre of the field) to prevent it moving, and then to place the thumb-nail of the left hand, or another slip of glass, against the left-hand edge of the object-slip, and hold it there while the object is taken off the stage and a finder is put in its place against the thumb-nail or slip, and read off as above explained, and the number of the squares recorded.

The finder will also be found very useful as a stage-plate for the draughtsman with the camera lucida.

If ruled upon disks for the eye-piece they are unique, as the plotting and the object are seen as one, either with or without the camera lucida or neutral tint glass.

The finders are all ruled and mounted so mathematically alike as to enable a slide to be marked and sent to any part of the world wherever a Webb's finder may be.

## XXIII.—*On Tolles' Interior Illuminator for Opaque Objects.*

By William A. Rogers, F.R.M.S.
(With Note by R. B. Tolles, F.R.M.S.)

(*Read* 10*th June*, 1880.)

The method of obtaining a sufficient illumination for opaque objects by admitting the light above the objective and reflecting it down through the lenses upon the object, is due to Professor Hamilton L. Smith, of Geneva, New York.

It is described in a general way in the 'Annual of Scientific Discovery' for 1866–7, page 147, and is generally known as the "vertical illuminator." The more recent modifications in the form of its construction by Powell and Lealand, and by R. and J. Beck, while adding perhaps a trifle to convenience in use, add nothing new in principle.

Two objections have been urged against this form of illuminator:—

*First*, That there is a great loss of light in the reflections from the surfaces of the glass plate, and by the diminution of the aperture in the case of the silvered mirror.

*Second*, That observers generally find the successful manipulation of it exceedingly difficult.

The second of these objections may be overcome by attaching the revolving mirror to an arm which receives its motion through a ball-and-socket joint, attached to the outside of the tube, within which the mirror revolves. The first objection is to a certain extent obviated also by this device, since the mirror, being perfectly under the control of the observer by means of the universal joint, all the rays of light which are available can be directed upon the surface to be examined.

Nevertheless, even with the modification of the universal movement of the mirror, this form of illuminator has not been found well adapted to the requirements of the special problem upon which the writer is engaged, viz. the comparison of standards of length and the investigation of their errors of subdivision. In the examination, for example, of two different metres, the illumination should be the same in kind, quality, and quantity for every graduation examined.

After having tried, as I supposed, every known form of illumination without success, I was delighted to find in Carl's 'Repertorium for Experimental Physics' for 1877, what appeared to be a new method of meeting the difficulties of the problem. In volume xiii. page 566, Professor Wild describes a vertical comparator which seems to meet in an admirable way all the difficulties which relate to the flexure of the bars upon which the graduations are traced. In this article he alludes briefly to the method of illumination which he adopted, as follows:—

"For central illumination of the divisions, small right-angular glass prisms are affixed in the interior of the Microscope near the objective, which are placed in the ends of short tubes and inserted through lateral openings, reflecting the exterior light which passes along the axis of the short tube vertically against the division, being still more controlled by the objective. This interior illumination is, according to my experience, preferable to any other. It produces sharp, well-defined images of the lines, and gives sufficient light even when diffused daylight falls upon the face of the prism."

Immediately upon reading this description I went to Mr. Tolles in order to obtain his assistance in the construction of an illuminator of this form, being ignorant of the fact that he had as early as 1866 made one of exactly the same form. Inasmuch as at least four persons seem to have independently suggested the use of a prism inserted between the two lenses of the objective for the purpose of securing illumination, it is well to insert here what I believe to be the first published account of the invention. I quote from the 'Annual of Scientific Discovery' for 1866–7, page 149:—

"Mr. Charles Stodder exhibited before the Massachusetts Institute of Technology, in December 1866, a new illuminator of opaque microscopic objects under high powers, the objective being its own condenser—the invention of Mr. Tolles.

"The principal difficulty met with in passing a beam of light down through the objective of a Microscope, and thus condensing a strong light upon an opaque object, is, in the case of high powers especially, the reflection back of a considerable portion by the lenses of the objective. This causes fog and obscuration of the image, though the object be well illuminated. This reflection takes place principally at the interior front surface of the front system.

"To obviate this difficulty, a small rectangular prism, immediately above the front system, is so far introduced into the side of the objective mounting as to slightly encroach upon the extreme margin of the upper surface of the combination. When the parallel rays are reflected by this prism down through the marginal parts of the front covered by it, they will have their focus much beyond the place of the object. As a medium case the distance of their convergence would be ten times the focal distance of the objective; consequently a much greater portion of the whole light incident upon the front system would be transmitted, and whatever amount experienced reflection would be dissipated by travelling back through the objective in a path widely different from that of the visual pencil."

During a recent visit to the Conservatoire des Arts et Métiers at Paris, I saw the device here described, attached to the Microscopes of the comparator, with which the operations of the French Section of the International Bureau of Weights and Measures are conducted. Its introduction is due to M. Tresca, who has used it since 1871. It is possible that the invention by M. Tresca may have been prior to this date.

Subsequently, during a visit to the establishment of Troughton and Simms, at Charlton, I mentioned to Mr. Simms that I had made use of this form of illumination in the Microscopes of the meridian circle of Harvard College Observatory, thereby securing far better definition and nearly ten times the magnifying power. After a moment's search Mr. Simms produced an illuminator of exactly the form described by Mr. Tolles and by Professor Wild, which he had constructed as early as 1869, at the instance of Mr. Warner, a retired gentleman residing at Sussex Place, Brighton.

According to the present evidence, the priority of publication, and, I believe, of invention also, must be assigned to Mr. Tolles. Without doubt M. Tresca was the first to make an actual use of this method of illumination in exact measurements.

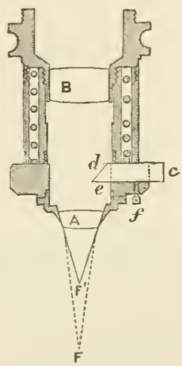
The objective of which a sectional view is given in Fig. 73, was made for me by Mr. Tolles, with special reference to its adaptation to the examination of the divisions of the copper-platinum metre of the X form which M. Tresca did me the kindness to trace. It has an aperture of 30° and a focal power of 1 inch. The front system of lenses is at A. The back system is at B. A rectangular prism, whose surfaces *c*, *d*, *e*, are ground and polished, is shown entering one side of the mounting, immediately above the front lens. Parallel rays of light entering at *c* pass into the prism, are reflected from *d*, emerge at *e*, impinge upon the front lens A, and have their principal focus at F; the focus of the objective being at F′, where the object is seen. The light having its focus at F is better distributed on account of the greater breadth of the pencil at F′. It might be supposed that if a condenser were applied to the prism, the light thereby being brought to a focus at F′, a better illumination would be secured. In actual experience, Mr. Tolles has found that this is not the case.

The prism is held in place by a spiral spring pressing upon a ring which fits rather loosely upon the tube. By means of the screw at *f* any required inclination can be given to the prism. The field of illumination can be regulated by pushing in or withdrawing the prism. When it is entirely withdrawn, the objective takes the ordinary form.

I find the prism useful in supplementing the light from the mirror below, when an intense illumination is desired with transparent objects. This method of illumination seems to be rather better adapted to high than to low powers. I have a $\frac{1}{4}$ with which the most perfect illumination of graduated metal surfaces can be obtained by simply turning the face of the prism towards a window. This method seems well adapted also to the resolution of bands of fine lines. If the lines are ruled on cover-glass, and are covered with a thin coating of either silver, gold, or platinum by the method of Professor Wright, of Yale College, the resolution will be effected about as well by looking at the lines *through* the coating as by viewing them by reflection.

The method of illumination here described has an especial interest in connection with immersion objectives. I will close this article with a communication with which Mr. Tolles has kindly furnished me, together with the sketches shown in Figs. 73 and 74.

Fig. 73.




"With immersion objectives the illuminator-front has still more effective and extended application:—

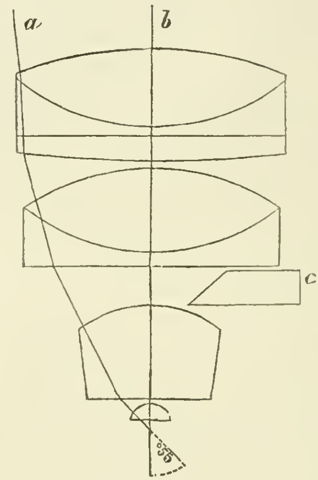
*First*, Because more of the front lens can be brought into use for the purpose of illumination than with dry objectives.

*Second*, Because any possible glare arising from the marginal zone of total reflection in the dry objective, has no existence when the front has water contact with the covering glass. This is strictly true in the case of the prism, while it might not be true in the case of a transparent disk of glass, placed as a reflector at the back of the entire objective system, and covering its entire aperture. Reflection from a disk might easily reach an outside zone of total reflection even with a water-immersion front, and give back stray rays which would cloud the view, but the prism would necessarily stop all rays not contributing to the formation of the image, even without the interposition of diaphragms. In the case of bands of lines, as in Nobert's plates, there would be for the most part exemption from glare, and the whole interior aperture of the objective would be brought into use, except that portion which is stopped by the prism. The angle of this interior aperture would be bounded *in a homogeneous immersion medium* by the extreme rays utilized by the objective.

Fig. 74 represents the front duplex system of the immersion $\frac{1}{6}$-inch objective made for Mr. Crisp in 1873. It is one of the very first made to demonstrate the practicability and the utility of the outside—'extra-limital'—immersion aperture. It has an exceptionally small front lens, but it will serve to show the convenient application of the prism to objectives of this class.

The rays *a* and *b* in Fig. 74, as traced by Professor Keith, show an angle of 110°, or 55° on each side of the axis. Rays, whether

Fig. 74.




parallel or divergent, entering the prism at *c*, would take the same general direction as the rays *a* and *b*, but their focal distance would be about thrice that of the entire objective. If the seat of the prism, as shown in Fig. 73, is in a plane at right angles to the optical axis, then the direction of the illuminating ray can be considerably controlled by raising or lowering the outer end of the prism by means of the screw at *f*, and the reacting spiral spring above."

# RECORD

OF CURRENT RESEARCHES RELATING TO

# INVERTEBRATA, CRYPTOGAMIA, MICROSCOPY, &c.*

## ZOOLOGY.

### A. GENERAL, including Embryology and Histology of the Vertebrata.

**Development of the Rabbit.**†—The recent observations of Professor Kölliker have shown him that on the fifth day the *area embryonalis* of the rabbit is made up of three layers; these are

(*a*) The cells of the investing layer of Rauber, which are flat and large and are part of the primitive unilaminate germinal vesicle.

(*b*) A layer of flattened, pretty thick, small cells, which he (as also Rauber) regard as ectodermal, while Edouard van Beneden looks upon them as forming the mesoderm.

(*c*) The cells of the endoderm are flat and large.

He finds that the investing cells of Rauber are temporary structures which have no relation to the formation of the ectoderm; this is, of course, in express opposition to the view of their future which is taken by Van Beneden, but it is one on which the learned German embryologist speaks very confidently; nor is this all, the mesoderm is stated not to appear till the time when the primitive stripe begins to be formed; when it does begin it takes all its origin from a thickening of the ectoderm, and has no relations to the endoderm.

The demonstration of the presence of a number of pieces of nuclei and cells in the young embryos, and their presence in number in the structures which are undergoing conversion, seem to show that at these stages the chief part is played by the growth of the cells, and not by any mechanical causes. The author promises further details shortly.

**Development of the "Glomerulus of the Head-Kidney" in the Chick.**‡—This structure has been already noted by Mr. Adam Sedgwick and Mr. Balfour, and Gasser has arrived at similar conclusions as to the characters of the structure. In the previous communication no definite answer was given to the point as to whether this glomerulus was a "continuous structure." A study of its development has since shown Mr. Sedgwick that it is not so, but that the external glomerulus or glomerillus of the head-kidney of the chick consists

* ☞ It should be understood that the Society do not hold themselves responsible for the views of the authors of the papers, &c., referred to, nor for the manner in which those views may be expressed, the object of the Record being to present a summary of the papers *as actually published*. Objections and corrections should therefore, for the most part, be addressed to the authors.

† 'Zool. Anzeig.,' iii. (1880) p. 370.

‡ 'Quart. Journ. Micr. Sci.,' xx. (1880) p. 372.

really of a "series of glomeruli of primary Malpighian bodies projecting through the wide openings of the segmental tubes into the body cavity." These structures seem to be found between the ninth and thirteenth segments, but the corresponding primary segmental tubes are never fully developed in the chick.

Further details (with figures) of this extraordinary and unexpected development are promised.

**Cellular Evolution of Protoplasm.***—M. Bordone, in a "thesis" under this title, commences with amorphous protoplasm as the simplest form of matter capable of containing life; its first stage in upward development is the leucocyte, which may arise, though rarely, in the tissues without origin from a cell. It then acquires a nucleus, and in this condition may form protoplasmic leucocytes by gemmation. This appears to be proved by the separation from mulberry-like masses in the blood of the *Axolotl* of granules which fuse together and grow by taking in foreign material. This division is preceded by multiplication of the nucleus, which occurs either by fission or budding, while in exceptional cases new nuclei may arise independently in the protoplasm; budding fission, or segmentation then operates to multiply the cell.

**Imperfection of the Geological Record.**†—Herr Fuchs contends that were the chronicles of past ages so imperfectly kept by the rocks as Mr. Darwin and his followers maintain, the study of palæontology would have an interest merely for curiosity collectors. On the contrary, the data already obtained from its study are so full as to afford a firm basis for the discussion even of such general questions as the Darwinian theory. Thus, the whole series of organisms may be divided into two groups, (1) one consisting of such as, owing to their peculiar habits, or to the soft consistency of their bodies, could only be exceptionally preserved as fossils (e. g. Medusæ, Ascidians, insects, birds, soft plants); (2) the second of those whose form, skeleton, and manner of life tend to their preservation (corals, &c.). These latter are preserved not as the consequence of chance, but in the natural course of the formation of sedimentary strata. How certainly their survival is owing to these conditions is shown by the discovery of a richly fossiliferous marl in digging the foundations of the Messina Docks; of the fossil shells found, about one hundred were known as living species, a few were not so known; these few, however, in time were added to the recent fauna by dredgings made in the Bay. Of 337 species of testaceous Mollusca found in the sea on the west of Italy, 300 are known to occur in neighbouring quaternary deposits. Comparing the richness in species of the most abundant recent molluscan fauna, that of the Philippine Islands, with that of the European upper chalk, or of the Bohemian Silurian basin, the two latter lose little by the comparison. All the indigenous European Ungulates are known in the fossil state. If such can be shown to be the case with

* See 'Rev. Sci. Nat., ii. (1880) p. 115.

† 'Verh. k.-k. Geol. Reichsanstalt,' xxix. (1879) p. 355; xxx. (1880) pp. 39, 61. See also 'Nature,' xxi. (1880) p. 476.

the many groups taken as examples, then the Darwinian theory must be demonstrable, if at all, from the evidence thus afforded.

Direct contradiction is also given to the evolutionist doctrines by the fact of the *periodicity* of the development of animal life which is seen to have been the rule in past times: i. e. epochs of active development were succeeded by times of comparative rest, and the development itself varied in intensity. It is contrary to the analogies afforded by the present order of things to suppose this to be due to changes in the external conditions, for these may cause redistribution but not transmutation of plants and animals. Again, the relation of the faunæ and floræ of consecutive geological periods to each other shows a *co-ordination* closely resembling that of those of neighbouring districts at the present time, in having a number of species in common, a number of decidedly different ones, and a small number of forms differing scarcely more than as varieties from some belonging to both districts.

If this relation is sought to be explained by the missing species yet to be discovered, it may be replied that if investigation succeeds in finding in one formation the (e. g.) 50 representative species necessary to show its absolute sequence upon the preceding formation, it is as likely also to find (e. g.) 500 more species in that formation, and thus set theorists again to work to find these species also in the beds following. The asserted *completion of the organic series* by fossil links is unfounded, for though, as in the Ungulata, many gaps are thus filled up (by *Anchitherium*, &c.), yet as many more are created by the discovery of wholly new types (as *Brontotherium*, &c.); so with the mesozoic reptiles and fish and Cephalopoda, and still more with the palæozoic fauna; in particular, Professor Claus's declaration (in a lecture at Vienna in 1876) of the surprisingly small help which he has derived from the fossil forms in making out the genealogy of the Crustacea, is brought forward in support. The number of its *zones of life* must be taken into account in reckoning the changes undergone by organisms in any geological period; for instance, 153 zones are distinguished from the Silurian to the present age, and 33 in the Jurassic rocks, the passage from each zone giving the necessary conditions for mutation of a species; but taking the actual number of such changes observed in the case of the Cephalopoda (a highly modifiable group), in passing through the Jurassic rocks, viz. 77, the conclusion is drawn that on an average only 24 periods of change can actually have occurred for any group of animals since the Silurian times, a number quite insufficient to account for the immense (asserted) development of new genera, families, orders, and classes since that time.

## B. INVERTEBRATA.

### Mollusca.

**Mollusca of the 'Challenger' Expedition.***—The Rev. R. B. Watson gives the following as a few points which stand out with special prominence as the result of his study of this material.

* 'Journ. Linn. Soc.' (Zool.), xv. (1880), p. 87.

"1. Depth is an important condition of molluscan life. That is to say, there really are shallow and deep water species and genera, though their bathymetric limits are not absolutely constant.

To some this may seem too self-evident and universally accepted a proposition to need statement. Such would have been the case some years ago, but dredgings from the deep sea have presented facts which demanded a revisal of received opinions on this point; and while the result in the main cannot be said ever to have been doubtful, and while the evidence of other branches of natural history has already been obtained in this same sense, it is desirable also to record the witness of the Mollusca of the 'Challenger' Expedition.

2. Temperature, even more than mere depth, seems an important condition in molluscan life.

It is needless to speak here of other conditions, such as light, or food, or oxygen, because, though there are extreme differences in these respects, and though their influence must be very great, still their precise amount, and the nature and direction of their effects, are too little known to afford foundation for more than guessing.

Pressure seemed likely to form a very important condition in marine animal life; the enormous figures representing the square inch amount of that pressure stirred men's imagination, and their fancies were supported by the fact that rapid transference to the surface from even a moderate depth destroys life; but these impressions were removed by a remembrance of the laws of hydrostatic pressure, and by substituting a gradual for a rapid transition from deep water to the surface. Temperature, however, remains as an undoubtedly important factor.

3. Great differences in these respects of depth and temperature prove barriers to distribution.

4. Great length of time naturally helps escape from these barriers, for in the lapse of years accidents are likely to occur enabling species to evade difficulties which would in ordinary circumstances prove insurmountable. Hence the finding of a living species in a fossil state will always justify the expectation of its having a wide local distribution.

5. Where barriers of depth and temperature do not check distribution, there seems, in ordinary circumstances, no limit to universality of distribution.

6. There actually are existing species whose distribution is universal, no barriers having availed against their passage.

7. Still there is no trace, even in these species, of essential, lasting, and progressive change.

I do not intend to overpress this point, for I allow that it presents merely negative evidence. I do not assert that there are *no* species of Mollusca which have essentially, permanently, and progressively changed. I only say there are some, even many, which have not done so, that I do not know any which have, and that the burden of proof lies with those who assert the positive. Evolutionists are in the way of saying that a thing being possible is therefore probable, and consequently is true unless the contrary be proved. I only wish to note that this is a reversal of all the laws of evidence in any case of fact whatever, and to add that, so far as I have had the opportunity of observation, no proof has reached me of progressive, permanent, and essential change in molluscan development."

**Antiquity of certain Subordinate Types of Fresh-water and Land Mollusca.***—Mr. White points out that of the minor groups into which some of the "comprehensive" genera of these forms have been divided, a large number had their origin in periods which were at least as early as the closing epochs of the cretaceous or of the eocene periods. After a technical demonstration of these points, the author, on reviewing the collections, finds that there are in it so many "familiar forms" that it seems difficult to imagine that a large number "were living contemporaneously with the last of the Dinosaurs." The changes these Mollusca have endured seem to be very remarkable; there was a "gradual desiccation of the regions formerly occupied by the great inland lakes," "the elevation of the whole Rocky Mountain system, and the establishment of the present great interior river-systems." Although some forms have disappeared, "the lines of descent of the numerous types which have reached us unbroken seem to be almost parallel," and the author comes to the conclusion that in some degree at any rate these types have had a "saltatory" origin, although he allows that the mode must always remain obscure.

**Development of the Digestive Tract in the Mollusca.**†—From an abstract of the researches of Dr. W. K. Brooks we learn that he has come to certain definite conclusions, of which the following note gives an account of some of the most important:—

(1) The polar globules mark the principal axis of the egg.

(2) When there are four equal spherules in the egg, the protoplasm of each is segregated; that which will give rise to the ectoderm occupies the formative end and is quite transparent.

(3) These formative ends separate as four micromeres.

(4) By their division, and by the separation of other cells from the formative end of the macromeres, an ectoderm is formed, which entirely covers the four macromeres except at the blastopore.

(5) These macromeres now become fused, and part becomes separated to form the endodermal layer of cells.

(6) The remainder divides into a large number of cells, which occupy an intermediate position.

(7) These are not food-yolk, but continue to grow.

(8) The ectodermal cells about the blastopore become converted into the shell-area.

(9) The mouth is an independent invagination of the ectoderm.

(10) Which does not become connected with the digestive tract until after the closure of the blastopore.

(11) The stomachal appears to be the same as the primitive cavity.

* 'Amer. Journ. Sci.,' xx. (1880) p. 44.
† 'Proc. Boston Soc. Nat. Hist.,' xxx. (1880) p. 325.

(12) The "rectal plug" changes its position from the centre of the shell-area to a point on the ventral surface, where it forms the definitive anus.

(13) The structure and history of the shell-area is substantially as described by Ray Lankester.

(14) Periods of rest very conspicuously alternate with periods of segmentation.

The above observations apply to the Pulmonata, and the history of the same parts in the oyster is not altogether the same; in both cases, however, the blastopore is converted into the shell-area, and the mouth is formed nearly opposite, by an invagination of the ectoderm. The anus is in both distinct from the blastopore, but the intestine of the oyster appears to have no relation to the "invagination neck."

Further details are promised, and will be welcomed, as the subject is one on which very various statements have been made by those embryologists who have directed their attention to this phylum.

**Action of Poisons on the Cephalopoda.***—M. Yung gives an account of the effect of certain poisons on the Dibranchiate forms on which he has been enabled to experiment:—

*Curare* when injected subcutaneously has no action, but if two or three drops were injected into the cephalic artery they almost instantaneously brought about a paralysis of the muscles of the mantle, and then of those of the arms; although the animal then appeared to be dead, the "hearts" continued to beat, and the chromatophores retained their activity.

*Strychnine* has a very powerful influence, for 1 part in 30,000 of sea-water produced a relaxation of the muscles of the chromatophore; the respiratory movements increased and then fell rapidly; tetanus shortly followed. The animal emptied its ink-bag, and a state of extreme muscular rigidity was induced; examination nevertheless revealed the fact that the venous hearts were still beating.

*Nicotine* is still more poisonous to the Cephalopod, but it produces a contraction of the muscles of the chromatophores, and the hearts were arrested in their systole.

*Atropine* appears to have a very complex action, large quantities are necessary to produce any effects, and these consist in the gradual lowering of the cardiac and respiratory movements.

*Veratrin* is an active poison, and produces irregularity of movement, and an arrest in systole of the hearts.

*Muscarin* has a similar action to nicotine on the chromatophores, but the effect is not so well marked; it would appear to slowen the circulation and to increase the secretions.

*Upas antiar*, when injected into the cephalic artery, has the effect of throwing the animal into violent convulsions, the cardiac movements become very irregular, and after a period of acceleration come to an end in the period of systole.

* 'Comptes Rendus,' xci. (1880) p. 306.

**Regeneration of the Head in Gastropods.***—The first to make experiments on this subject was the eminent Spallanzani; and he was followed by Pastor Schäffer, of Regensburg (1768–1770); these observations have been greatly neglected, but Professor Martens does well in referring to them in the note in which he deals with the recently published results of Justus Carrière. This naturalist confirms the observations of his two predecessors; eyes, tentacles, labial processes may be completely regenerated, but not the pharynx, or the supra-œsophageal ganglion, the destruction or removal of which is always accompanied by the death of the animal. More scientific than his predecessors, M. Carrière was always careful to see that he had really got, in the removed portion, the organ he intended to take away. Moreover, certain conditions are necessary to attain to complete success; the animals must be in the most satisfactory vital conditions possible, and must have their requirements in the way of air, food, and water carefully attended to; the experiments generally fail if undertaken at a time when all the energies of the animal are directed to the formation of the generative products; the beginning of summer and the autumn season are the most satisfactory times. As to the species, *Helix nemoralis* and *H. hortensis* give the best result; *H. pomatia* is more sensitive, and *H. arbustorum* and *H. fruticum* are still more so. Aquatic Pulmonata give frequently unsuccessful results, owing to the fact that fungi are very apt to become developed on their wounds. It may be suggested that the antiseptic treatment can be applied to physiological as well as to pathological operations.

It is interesting to note that the observer has found that in the case of the eyes, at any rate, the process of regeneration is comparable to that of the first formation of that organ. There is an invagination of the epithelium, the formation of a closed vesicle, the primitive cylindrical cells become partly converted into corneal cells, and partly into rods and cones. The complete regeneration of the eye takes from fifty to sixty days.

**Activity and Structure of the Muscles of Mollusca Acephala.**†—M. Constance has experimented on the scallop, on oysters, on *Anomia*, *Pectunculus*, *Venus*, *Cardium*, *Mytilus*, by pricking, striking, by induction currents, and by changes of temperature, and finds that of these agents the current of electricity is the most powerful and constant in its action. The muscles consist partly of striated fibres in *Pecten*; in the rest of these Mollusca the striated muscle is replaced by smooth fibre of a special kind; in the *Dimyaria* the two kinds may be distinct. Both contraction and extension are voluntary actions, and can be increased or rendered independent by ammonia vapour, chloroform, &c., which, together with changes of temperature, cause various degrees of paralysis of the sensitive organs.

**Pedal Glands of the Tellinidæ.**‡—In *Tellina* (*T. baltica*) M. Barrois finds a small posterior opening on the foot, leading into

* 'Naturforscher,' xiii. (1880) p. 272.
† 'Bull. Soc. Acad. de Brest,' 1879. See 'Rev. Sci. Nat.,' ii. (1880) p. 117.
‡ 'Bull. Sci. Dép. Nord,' iii. (1880) p. 193.

a canal which ends in a larger cavity, plicated and lined with glands; these structures represent the byssal apparatus of those Mollusca which possess it. The canal represents the open groove of *Cardium edule* and the half-closed groove of *Pecten maximus;* but these species have also certain glands situated in it, which have no homologues in *Tellina;* its terminal glands, however, represent the byssal glands.

*Scrobicularia piperata* differs in the arrangement of these parts from *Tellina* only by the inferior length of its canal.

In *Donax anatinum*, the opening is also posteriorly placed; the canal is short and leads into a cavity whose walls are covered with cylindrical epithelium; no gland cells occur, they are replaced by an extremely dense mass of connective tissue which is not stained by reagents and shows no trace of gland cells. This is the furthest stage of degradation reached by the apparatus of the byssus in this family.

Thus in these forms the opening of the duct is transferred from front to back, the groove is replaced by a canal, the glands of the groove are entirely lost, and in one of the species (*Donax*) the byssal glands are aborted.

**Anatomy of the Bullidea.***—M. Vayssière is principally occupied in this essay with the description of that imperfectly known form *Gasteropteron Meckelii;* but the difficult family to which this species belongs presents several points in which our knowledge is very far from being satisfactory; its representatives differ considerably from one another in their external characters, and some among them are almost completely deprived of any shell. Members of the group may, however, be recognized by the facts that the dorsal region of their body is divided into four parts, and that both labial and dorsal tentacles are altogether absent.

It will not be necessary to follow our author through the historical chapter in his paper; coming at once to the genus *Gasteropteron*, we find that in it there are at any rate no more than two described species, *G. Meckelii* of Kosse, and the very slightly different *G. sinense* of A. Adams. The former species, with which alone the French naturalist now concerns himself, is from 20 to 24 mm. long, and from 25 to 30 mm. broad; the body proper is even much smaller than this.

In its general appearance it has no slight resemblance to a Pteropod, and in that order the earlier naturalists were content to place it; the shell is somewhat difficult to detect, and was never observed till 1860, when Krohn signalized its appearance; it is only 4–5 tenths of a millimetre in size, is "nautiliform," hyaline, and very translucent, so that it has a very striking resemblance to that of a *Carinaria;* it is found in the hepatic organ, is situated near to the anus, although somewhat behind this orifice, and a little on the right side.

*Digestive System.*—This portion of the animal is exceedingly simple; the oral orifice is situated in the centre of a slight depression, and just in front of the anterior portion of the foot; on either side

* 'Ann. Sci. Nat.,' ix. (1880), Art. 1.

there are slight projections, and these give rise to the parapodia, which aid in forming a kind of funnel-shaped orifice. Just behind the mouth there is a short, eversible proboscis, and connected with this there is the obscure structure which is known as the buccal bulb; this somewhat elongated organ is ovoid in general shape, and has behind the two swellings with which it is provided a cylindrically shaped prolongation, which is the seat of origin of the radula. The muscles of this bulb are, consequent on the absence of any chitinous skeleton, exceedingly well developed; chitinous parts are, however, developed from the epithelial cells of the bulb, and at once become sufficiently strong to form two small resisting plates, which may well be regarded as rudimentary jaws. These have an interesting structure; they are made up of a number of small, irregularly cylindrical rods, closely set and all directed towards a common central point. That they are rudimentary jaws would appear to be sufficiently well established by the comparison which the author has instituted between them and the similar structures of a further grade of development which are to be found in *Bulla* and in other allied genera. In addition to these rudimentary jaws, small chitinous papillæ have been detected at the point where the proboscis passes into the bulb. The support for the radula occupies the base of the buccal cavity; the radula itself forms a band which is twice as long as it is wide, the central portion is unarmed and only presents some, always small, chitinous granules or concretions. On either side there is a longitudinal row of well-developed teeth, and on these there follow five parallel rows of smaller lateral teeth (uncini).

The œsophagus takes a course a little towards the left, and then descends to a somewhat lower plane, where it passes into what the author calls the second cavity of the body; it becomes at once continuous with the stomach. This portion of the tract, in which no gizzard seems to be developed, is enveloped by the "hepatico-hermaphrodite mass"; the internal epithelium is provided with a number of short cilia. As an ordinary rule, there open on its surface ten distinct hepatic orifices. The walls of the intestine are even more delicate than are those of the stomach, and they have no proper coloration; what they have is due to their contents. This region, somewhat equal in calibre to the œsophagus, is not dilatable; after some coiling it ends on the right side, in a little pit behind the respiratory apparatus. Towards its termination the musculature of its walls becomes better developed; Foraminifera, Radiolaria, and diatoms appear to form the chief food of these molluscs.

The salivary glands form two long, white, hyaline sacs without ramifications, and placed one on either side of the œsophagus, which they follow along its course, although without contracting any connection with it, and they open into the buccal cavity by narrow ducts, just above the œsophagus. The glandular layer is formed of two rows of cells, of some size but irregular in form; their nucleus is distinctly visible.

The liver, contrary to what obtains in most of the Opisthobranchiata, is not compact, nor does it open into the stomach by a single orifice. It is made up of a certain number of completely separated glands, while each has a special duct which opens directly into the stomach. These ducts and the lobes of the glands do, however, become somewhat entangled, and thus give rise to the appearance of a single compact mass, by which the subdivision of the organ is at first sight obscured. Ten distinct lobes may be generally made out. The ultimate cells are large, polymorphous, and variously coloured; they contain vesicles which may either be scattered through the cell or aggregated into a small central mass; they vary in colour through different shades of yellow.

The author applies the term *independent glands* to certain distinct structures; these are (1) Circumoral glands and (2) posterior gland of the foot. The former are found in the integument around the orifice of the proboscis, and within the first cavity of the body; they vary a good deal in form, but always end in an excretory duct, which opens at the entrance to the orifice of the proboscis. Their contents are hyaline, and are made up of nucleated vesicles with a nucleolus, and granular bodies suspended in a colourless liquid. They are not, as the author first thought, unicellular glands, notwithstanding the simplicity of their structure. Their function appears to be that of assisting in the prehension of the microscopic organisms which form the food of these creatures.

The posterior gland of the foot appears to have escaped notice altogether; this is the more remarkable since it is visible to the naked eye. In general constitution this gland has much the same structure as those around the mouth; its secretion is in the form of a rich supply of mucus, which seems to form a kind of raft for the animal, and thereby to enable it to float on the surface of the sea.

The *organ of Bojanus* is of some size, is placed on the right side of the body, is of an ochreous yellow tint, and somewhat translucent. Spongy in constitution, its cell-elements are spherical in form, and among their contents it was not possible to detect any crystals of uric acid. On its external wall there is, in front of the anus, a constant black spot; this, on careful examination, was seen to have in its centre five or six small orifices, by means of which the gland communicates with the exterior. The walls of the gland are, as is usual, richly supplied with veins.

*Red Gland.*—This gland, the presence of which the most superficial observer cannot fail to detect, extends over a portion of the intestine and over the walls of the "copulatory pouch." Its constituent cells, though smaller, are not unlike in character to those of the organ of Bojanus; the contained granular bodies are greyish or of a bright red, and disappear altogether under the action of acids. The author is forced to content himself and his readers with an account of the structural characters of the body, as he is unable to offer any definite suggestion as to what its function may be.

*Respiratory and Circulatory Organs.*—These must be dealt with very briefly; the former consists of a semi-pinnate branchial plume, made up of a number of lamellæ, more or less free at their extremity, and invested by an excessively delicate tissue. The external orifice of the "aquiferous system" appears to lie a little above the genital orifice; the heart has its long axis set transversely to that of the body, and the ventricle is, in position, a little superior to the auricle; the aorta is a vessel of some size which bifurcates at a very short distance from the heart into an anterior and a posterior aorta. These and their branches have their course described in some detail; but, in consequence of the rarity and small size of these creatures, the author is not able to make this chapter as complete as he could wish.

*Reproductive Organs.*—Hermaphroditism appears to be especially complete in *Gasteropteron*, for there is only a single duct for the pur pose of carrying away the male and female products. But our space does not permit us following the author through his important account of the details.

*Nervous System.*—The œsophageal collar is formed by three pairs of ganglia, connected together by commissures of different lengths; all these—cerebral, pedal, and visceral—are placed more or less to the sides of the collar, but the first have, of course, a more distinctly dorsal position. Among the protecting parts we may note a mass of hyaline cells which appear to be in relation to the integument; recalling by their character hypodermic glands, they seem to discharge a more or less mucilaginous fluid which aids in lessening any shocks to the nervous centres.

After giving a detailed description of these ganglia and of the nerves which pass off from them, the author turns to the stomatogastric and to the genital ganglia; the sense-organs are next dealt with, and here we have to note that, although the dorsal tentacles are in all Bullidea completely wanting, and are partially replaced by the cephalic disk, this last-mentioned organ must not be considered merely as an atrophied tactile organ, for the olfactory sense, which is ordinarily exercised by the extremity of the tentacles, has its seat in a more or less well-marked differentiation of that portion of the integument which lies between the cephalic disk and the foot; in *Gasteropteron* this sense seems to be completely absent, but the tactile organs are, as compared with the allied forms, very richly developed. After a description of the optic and auditory organs, the author passes to

*The Anatomy of some Allied Genera* (*Doridium*, *Philine*, *Scaphander*, and *Bulla*); of this the following is a very brief abstract.—The most striking point in *Doridium* is the structure of its copulatory organ; in this genus the penis does not, as in most Mollusca, form a thick-walled tube, but a canal not completely closed, for four-fifths of its length the left edge of the canal lies over the right, but at its superior extremity there is a kind of groove, which is so formed that the orifice of the duct is not terminal, but ventral in position.

In *Philine* and *Scaphander* the salivary glands are very short and cylindrical, instead of being elongated as they are in most members of this family; there are only two hepatic orifices, and the circumoral glands are feebly developed. The olfactory and optic organs are exceedingly rudimentary; the penis of *Philine* is hammer-shaped, while in *Scaphander* this organ is completely absent.

As to *classification*, M. Vayssière does not find himself in agreement with Ihering, who would separate *Gasteropteron*, *Philine*, and *Scaphander* from the Bullidea; the French anatomist would, however, retain Woodward's family, and would form in it two subdivisions, in one of which *Gasteropteron* is the only genus; these two subdivisions may be thus characterized. In the first, the parapodia are largely developed, a small nautiloid shell is contained within the mantle, and the œsophageal collar is made up of a pair of cerebral ganglia, of a pair of pedal, and of six visceral ganglia; the last being arranged by three to the right, and three to the left.

In the second division the parapodia are always rudimentary, the shell is always very distinct, is never nautiliform, and may be well developed and external; there are only three visceral ganglia in the œsophageal collar, and of these, two are placed to the right, and one to the left. Here, too, we find that the genital nerve always arises from the larger of the two left visceral ganglia, while in *Gasteropteron* it arises directly from the commissure without the intermediation of any ganglionic enlargement; while the branchial nerve, which, in *Gasteropteron* always arises from the right visceral centres, may in them be derived from the right visceral ganglion, from the right half of the commissure, or from a ganglion placed in the middle of this connecting cord.

**Development of Teredo.***—Dr. Hatschek has extended his observations in development to the Lamellibranchiate Mollusca.

The youngest *ovarian* ova are pyriform in shape, and are attached by their stalk to the wall of the ovary; the germinal vesicle is excentric; the fertilized ova and the embryos are found within the gills of the mother, where in numerous individuals it is often possible to see three different stages; the older being in the more anterior region. It is soon possible to observe in an unsegmented ovum a clear animal and a darker vegetative pole; after the first segmentation we have two unequal spheres, the smaller or more anterior of which is not so dark as the other, in consequence of the less close packing of the yolk-granules. The author is of opinion that in all Bilateria a bilateral symmetry is to be made out in the ovum, just as in all Metazoa there is a polar differentiation of the same cell. Observations on the process of segmentation show that the ectoderm is formed from the clearer cells, while the unpaired larger segmentation-sphere goes to form the mesoderm and endoderm; no cleavage cavity was to be observed.

The rudiments of the former of these two inner layers are developed from the large dark cell by the separation of a smaller piece, which occupies the hinder pole of the embryo and divides into two cells which become placed symmetrically, one on either side; they are darker than the ectodermal cells, and their nuclei are larger, so that they altogether resemble in character the primitive mesodermal cells of *Unio*, *Planorbis*, *Pedicellina*, and the Annelids.

The gastrula arises by epiboly and its free edge is formed by the ectodermal layer; there is still a single large endodermal cell, which does not become divided for some time, and, even after the commence-

* 'Claus's Arbeiten,' iii. (1880) p. 1.

ment of the formation of the œsophagus, there are only two endodermal cells. As the embryo changes from its ovoid form, we get a flattened pre-oral, a conical post-oral, and a rounded posterior region. With high powers it is possible to see, at some distance from the mouth, a double circlet of delicate cilia, supported on two special rows of ectodermal cells.

The two large ectodermal cells divide, and form the posterior endodermal mass; a double pre-oral ciliary circlet becomes developed. Soon the whole surface of the embryo is covered with cilia, the only naked region being a portion of the hinder part of the dorsal surface. The ectodermal cells begin to form a shell-gland, and this, at a later stage, forms a deep thick-walled saccule with a narrow cylindrical lumen; its orifice and margin are covered by a delicate chitinous cuticle, which represents the earliest rudiment of the shell, and indicates thereby the primitively unpaired condition of this organ.

From the primary mesodermal cells two or three smaller ones have been budded off on either side, and pushed forwards; the characters of these parts strongly call to mind the arrangements which obtain in *Criodrilus*. The shell becomes double while still very thin, and almost cuticular in character.

At a somewhat later stage the form of the body and the rudiments of the organs call to mind the disposition of parts in the trochophore stage of the Annelid-larva; the stages next succeeding are very markedly affected by the development of the shell, which has grown considerably, and about this time the double pre-oral circlet of cilia disappears. The development of the musculature is now rapidly going on; and a number of separate parts soon become well marked; still do the primitive mesodermal cells retain their large size. As the shell grows, takes on a yellowish coloration, and becomes marked by parallel lines of growth, the characters of the ciliation become much changed; cilia have disappeared from the frontal area and from the ventral surface; in the oral region, pre-oral, post-oral, and adoral zones are to be distinguished.

As the larva at this stage is completely trochophoral, save only as regards the presence of a shell and a mantle to indicate its molluscan ancestry, we have to look for a similarly well-marked excretory organ; this, just like the kidney of the Trochophore, is to be found at the anterior end of the mesentery, where it forms a longish organ, with a delicate lumen, and ciliated internally. As this body elongates it becomes connected with the ectoderm and gets to open to the exterior by means of an orifice in this layer.

As we cannot follow the author through all his further details, we will pass to the concluding part of this descriptive chapter, in which he speaks of the development of the gills. In the mantle cavity, at the sides of the trunk, there appears a ridge of ectoderm, which belongs to the inner lamella of the mantle-fold. Later on, the hinder portion of this branchial ridge gets set at right angles to the anterior, and at the angle the rudiment of the gill is best developed. At a point near the free edge the two layers, of which the fold is composed, become thinner; depressions appear in this which lead to the breaking up of the gill, which, at about the same time, becomes marked off from the inner mantle-lamella by the ingrowing of the fold.

After some considerations on the early appearance of the bilateral arrangement, to which attention has been called above, the author says that, with the exception of the Echinodermata, the Trochozoon appears to be the primitive form for all the rest; Worms, Molluscs, Molluscoids, Arthropods, and Vertebrates may therefore be distinguished as *Eubilateria.* The blastopore closes along the middle line, and the mouth appears at the point at which lay its final remnant; the formation of an ectodermal fore-gut appears to have happened very early, and, after this, the formation of the mesoderm is the oldest phenomena. The mode of development of the mesodermal organs is a matter of great interest; in the Annelids the differentiation of the mesodermal bands leads to the distinction between the head and trunk; the relations between the trochophore and the Teredo-larva are so close that their common ancestry is not to be doubted; the early development of the shell is only another example of the appearance before its historic time of an organ which plays an important part in the organization of the individual.

When we try to trace the phylogenetic history of the mollusc, we see that there were added to the organs of the Trochozoon, first, the ventral ganglion of the trunk with the auditory vesicles, the paired trunk-kidneys, opening by special ciliated infundibula into the secondary cœlom; and the dorsal heart. These organs characterize the primitive ancestor of both annelids and molluscs; then, for the mollusc, there appeared the hepatic diverticula of the stomach, the dorsal shell, the mantle-fold, the muscular foot, and the primary gills.

When the foot appeared, the free-swimming mode of life was lost, and the velum began to atrophy. If this be really the true history of the Mollusca, it is clear that the "step-ladder" form of the ventral ganglia (Ihering) cannot be regarded as an indication of a pre-existing segmentation. The lateral approximation of the pedal ganglia is a secondary character, and so, much more, is the approximation and final fusion of these centres with the œsophageal ganglion.

Do the facts of development as now known to us support the monophyletic or the polyphyletic (Ihering) theory of the history of the Mollusca? Hatschek believes that the ventral ganglia took their origin from an ectodermal thickening on the ventral side of the trunk-region, and that their approximation to the œsophageal ganglion in the Nudibranchiata is the result of a secondary process. Ihering would think that in (his) Platycochlides the supra-œsophageal, as well as the pedal ganglia, had their origin in the frontal plate. Further investigation of known facts, and further study into still unexplored regions, can alone decide what answer is to be given to these two questions.

### Molluscoida.

**Development of Lingula.***—M. Joliet has an analysis of Mr. W. K. Brooks's important contribution to this subject, to

* 'Arch. Zool. Exp. et Gén.,' 1880, p. 390.

the general conclusions of which we direct attention. Dealing with the zoological position of the Brachiopoda, the author points out that embryological investigations have shown us that the resemblances between the gills of Tunicates, Brachiopods, and Lamellibranches are adult characteristics which have been arrived at by very different ways. The larvæ of the higher Brachiopods present a striking resemblance to the larva of *Loxosoma;* those of lower forms, e. g. *Lingula*, have a striking similarity to the adult (and especially to the fresh-water) Polyzoa; the author's facts seem to him to show conclusively the real resemblance between the two groups. When the adult instead of the young is examined, we have incontestably to do with a solitary Bryozoon, provided with a nervous system and with highly specialized sensory organs. The relations of the Brachiopoda to the Vermes are much less distinct than Morse imagines; their relations to the Bryozoa are very definite. As to this last, its affinities to the Veliger-form are quite apparent; the velum corresponds to the lophophore, the epistoma with its ganglion corresponds to the foot and the pedal ganglion; the shell and its operculum correspond to the cell and operculum of the Cheilostomatous Polyzoa, and the retractor muscles are "clearly homologous." The Brachiopoda, then, may be taken to be the most highly specialized representatives of the Bryozoan branch, and the Mollusca proper have a similar relation to the *Veliger*-phylum.

In conclusion, the author insists on the long persistence of *Lingula* as showing that the facts of zoology absolutely forbid us to believe that there must be a continuous evolution of forms owing to a continuous progress upwards.

**Structure of Adeona.***—Dr. Kirchenpauer has given the first detailed account of one of the most curious and but little known of the Bryozoa. In 1812 Lamouroux described *Adeona*, and at first placed it among the Isidinæ, but subsequently under Escharidæ, which included *Eschara*, *Retepora*, *Krustensterna*, *Hornera*, *Tilesia*, *Discopora*, *Diastopora*, and *Cellepraria;* but as no figures of the minute structure were given, it remained doubtful if Lamouroux had correctly placed the genus. In 1819 Schweigger, who considered it related to *Nullipora*, discussed both among the corals, but gave very fair figures showing the zoœcial cells of the Bryozoa; the work is, however, probably known to few.

The structure of *Adeona* is interesting in several particulars, but more especially in the jointed radical, upon which character the genus as now described is established. This consists of calcareous joints with irregular chitinous intervals, forming a flexible stem much like *Isis*, so that it has naturally been frequently compared to it. Kirchenpauer finds, in making sections through this radical, that there are fine connecting tubes passing from the chitinous portion through the calcareous joints. In one species the zoarium from which this root springs is a calcareous foliaceous growth, much resembling in shape

* "Ueber d. Bryozoen-Gattung *Adeona*," von Dr. Kirchenpauer, 'Journ. Mus. Godeffroy,' 1880.

*Eschara foliacea* var. *angustifolia*. In other species, however, the zoarium consists of a flat reticulated or fenestrated flabelliform lamella, consisting of a double layer of zoœcia, having the characters of *Lepralia*, as we now understand it, according to Mr. Hincks's classification.

The calcareous stalk, from which grow one or many of these jointed roots, is pointed at the base, and spreads out in the flabelliform manner mentioned. This is strengthened by numerous ribs, which spread through the zoarium, reminding us somewhat of the ribs of a leaf, and these, besides bifurcating, sometimes anastomose. Microscopical sections show that these thicker parts, which we are obliged to speak of as ribs, are formed by a thickening of the lamella; for here, instead of finding the zoœcial chambers near the surface, they are found back to back in the median line, and over them is a considerable thickness of calcareous growth, which seems to be similar to that found in the older parts of *Myriozoum* and *Eschara*, where the oral aperture is often covered by a growth two or three times larger than the zoœcium.

All known species of the genus are from Australia and South Africa, and the root structure is sufficiently characteristic for them to be kept together at present, though it may be found advisable in the future to base classification more entirely upon the form of the zoœcial cell.

**New Genus of Polyzoa.***—Mr. J. B. Wilson describes a new genus of Cheilostomata closely allied to *Catenicella*, and to express that affinity the name *Catenicellopsis* has, at Professor McCoy's suggestion, been given to it. The two species as yet known are separated from *Catenicella* on the same ground that was considered sufficient to justify the separation of *Alysidium* from that genus, namely, the mode of branching.

The diagnosis of the genus is: Cells arising, for the most part, from the upper and back of other cells by a short chitinous tube; cells at each bifurcation commonly geminate; cells also frequently arising by a short chitinous tube from the side of another single cell, immediately below the lateral process.

The two species are *C. pusilla* and *C. delicatula*, the first growing on *Cystophora* in small glassy tufts about ½ inch high, and the latter on sea-weed or larger forms of *Catenicella* in tufts 1 and 2 inches high.

## Arthropoda.

### α. Insecta.

**Little-known Organ of the Hymenoptera.**†—The organ, as described by MM. Canestrini and Berlese, consists of a depression on the first tarsal joint of the first pair of legs, and of a spur at the apex of the tibia, either simple, bifid, or armed with spines, and often protected by a chitinous sheath. The spur is a modified spine, for two spines are found in the same position on the second and third

* 'Journ. Micr. Soc. Vict.,' i. (1880) pp. 64–65 (1 plate).

† 'Bull. Soc. Veneto-Trent.,' i. (1880) p. 154.

pairs (in other insects on the first also); of these one persists in the first pair as the spur above mentioned, the other becomes rudimentary. No muscles for moving the spur have been found, and its function is that of cleaning the tongue, and perhaps the antennæ also. These conclusions were derived from a study of many families of the order.

Honey-bearing Ants.—At p. 242 we gave a short account * of the Rev. Dr. McCook's observations on some of these ants from Colorado, which with the head and thorax of a small ant have all the posterior portion of the body distended into a reservoir of honey, the size of a large pea and of a rich translucent amber hue. The creatures cling to the rough roof of the chambers with their feet, the honey-bag hanging downwards. Not only is the abdomen converted into a receptacle for honey, but the whole internal economy of the body is transformed for this purpose; all the organs of the abdomen having quite disappeared, and there remains only a thin transparent skin. Dr. McCook was able to discover that the working ants, returning from their outdoor foraging with their bodies distended with the honey they had harvested, eject it from their own mouths into those of the honey-bearers, whose bodies thus become distended with it. The honey-bearer seemed to slightly contract the muscles of the abdominal skin, forcing from its mouth minute globules of honey; these clung to the hairs of the under lip and were eagerly lapped up by the hungry ants waiting to be fed. It is probable, however, that the supplies are principally intended as winter-stores for the workers, for feeding the larvæ, or for the queen.

Since the period when the above observations were made, Dr. McCook has had under his constant supervision an artificial formicary of the ants, and has made some further interesting communications in regard to them.† The most striking points relate to two particulars, one bearing on the sympathy, or spirit of beneficence, of the ants; the other relating to their anatomy.

Sir John Lubbock has shown that while ants were full of hostility against individual foes, they showed no sympathy for friends in trouble. The comfort of the poor honey-bearers, for instance, while the workers were excavating, was utterly ignored. They lay helplessly where they had been dropped, and were treated by the other ants as if they had been so many lifeless impediments to their work. Instead of making a detour around them, the workers went straight forward, clambering over any that lay in their path, and even dropping the pellets of earth which they brought out from the excavations upon and around them, until some of the honey-bearers were almost buried. There seemed here a lack both of sympathy and of intelligence.

The honey-bearers are not, however, quite helpless; they have the full use of their legs, though their movements are necessarily made at a disadvantage, from the angle into which the head and thorax are thrown by the swollen condition of the abdomen; yet they

* See also 'Journ. of Science,' ii. (1880) p. 87. † Ibid., p. 430.

have been observed to move by their own efforts, and it is not impossible that they themselves regain their favourite position on the ceiling of the nest when accidentally displaced. The reason of their preferring this position may be from the uncomfortable attitude which they are forced to assume on the floor of the nest. The workers, so far as could be seen, made no attempt to replace them. It may seem that an intense muscular effort would be required to sustain their great weight in this position. That ants, and insects generally, are excessively muscular, as compared with the larger animals, is well known. And the honey-bearers are more muscular than ants generally, their legs being simply bundles of powerful muscles. But it is rather difficult to conceive how muscular effort can be brought to bear to overcome the action of gravity in this position, unless by some clasping of the terminal hooks of the feet around the excrescences of the rough ceiling. It seems more probable that support is gained by the action of the sucking-disk, which ants possess in common with many other insects.

An observation of some importance in respect to the question of ant intelligence is that regarding the demeanour of the ants towards dead honey-bearers. In this case it is their habit to separate the head and thorax from the honey-bag, burying the former in the fixed cemetery which these ants usually establish in the earth outside their nests. But though the honey-bag remains, full of its sweet contents, the ants—either from respect for the dead or from lack of mental power to devise a new means of getting at its honeyed freight—seem to make no effort to penetrate its transparent wall. This is singular, in view of the avidity with which they will lick up the smallest portion of sweet food offered them in any uncovered condition.

As to their anatomy, it was previously said that the whole abdomen appeared to be occupied by the honey, its organs seeming to be obliterated, so that only a thin transparent skin remained. But anatomical observation shows that this external appearance does not give the true facts of the case. All the abdominal organs remain, but so strangely distorted and compressed as to be almost imperceptible. The fact is that any of these ants may, if necessary, be converted into a honey-bearer, and that the worker, when on her way home with her abdomen distended with the fruits of her nocturnal labour, has made a step towards the condition of the fully developed honey-bearer.

Of the three special expansions of the intestinal tract of the abdomen of the ant (the crop, the gizzard, and the stomach) it is the crop, into which the œsophagus immediately opens, which is the recipient of the honey. As its stores increase, by continual additions, it expands more and more, pressing outward the extensible walls of the abdomen, and compressing the remaining portions of the intestine into a smaller and smaller space. In a fully laden honey-bearer the crop has become so expanded that it fills nearly the whole interior of the greatly dilated abdomen; the dorsal vessel, or heart, being compressed and flattened against its upper wall; while the gizzard, stomach, and intestine are similarly compressed against the posterior wall. The compression of these organs is so great as seemingly to preclude their functional action, the stomach appearing to be quite incapacitated for its normal office of digestion. Yet the continued vitality of the ant is sufficient evidence that alimentation must still exist; and as it is not at all probable that the crop could assume the function of a digesting organ without injury to its stores, it seems as if some of the liquid food must make its way into the stomach and intestine, despite their extreme compression, and be there prepared for aliment.

It is, in fact, a puzzling question. Dr. McCook is inclined to think stomach digestion in some instances impossible. But the continued vitality of the ant seems to render it necessary, despite its apparent impossibility.

**Structure of the Lampyridæ with reference to their Phosphorescence.***—The Rev. H. S. Gorham arrives at the conclusion that the sexual instinct has played a large part in moulding the external structure of this group of beetles, and that it is to that we may look for an adequate explanation of the development of phosphorescent light, though, perhaps, not for its origin.

In the first place, it is to be observed that all the species of this family do not possess the luminous faculty in equal degree; but that on the contrary, while some are highly luminous in both sexes, some are only highly so in the female, some are not luminous in either sex, and some (though this appears rather doubtful) are luminous in the males, and not so, or much less so, in the female.

The part which this faculty of emitting light plays in the economy of nature has been long and earnestly debated. The most general view, and one which the author's observations tend to confirm, is that it serves as a beacon to attract the male to the female; but he believes this to be the case only in a special sense in those species which do not assemble, and especially in those in which the females are incapable of flight. In other cases he believes that *both* sexes are attracted, and enabled by this means to assemble at night for their union. These inferences are drawn from the consideration of the relative development of the eyes, together with what is known of the habits of the various species.

The eyes of the Lampyridæ are, he finds, developed in magnitude according to the amount of luminosity of the species considered; and the other parts which he has taken account of, together with these, are the antennæ, of which there is a very great diversity, both between the sexes and in the genera; the elytra, which are also subject to sexual and generic limitations, and finally the size of the abdomen in the female.

The last-mentioned is no doubt, as in other apterous females, the result of an increased production of ova. These are in the Lampyridæ laid on roots and other substances near the ground, where the

* 'Trans. Entomol. Soc. Lond.,' 1880, pp. 63–6.

young larvæ will at once be likely to meet with their molluscan diet. The greater the tendency to produce ova in abundance the more sluggish the females would become, and hence females once capable of flight would lose the use of their wings, and the usefulness of the light to attract their more volatile partners would be greater than ever. This he believes to be the explanation of the fact that the highest degree of light, or at any rate the greatest disproportion in the amount shown by the sexes, is to be found in those species which have apterous females, and together with this the greatest development of eye in the male.

The species in which both sexes are winged, and in which both are luminous and in probably nearly equal degree, are, the author thinks, by far the larger proportion of the whole number of existing species. In this case the power of emitting light would be obviously useful in attracting both sexes to assemble in swarms, and it does not militate against this supposition that in many species the males should possess this faculty in the higher degree. It might be anticipated that if the female has to be guided to the rendezvous of the species by this effect, the eyes in that sex would not be inferior to those of the male; and such is the fact. One well-known case is the European and Eastern genus *Luciola.* Here both sexes fly, both are luminous, and both have largely developed, powerful eyes.

Neither of these sections, however, comprise those species which are generally regarded as most typical of the family, the largest, and those which appear on the whole to have all their parts most highly specialized, and which, therefore, we place at the head of a systematic list, such as the genera *Lamprocera* and *Cladodes.* It is rather remarkable that in these genera the light-emitting faculty has not been developed in the same proportion as the rest of the organs have, and that while one of these, viz. the eyes, are also reduced in a direct ratio with the light, and are small and uniform in both sexes, another organ, the antennæ, is developed in inverse ratio as the phosphorescence is diminished. It is not intended to refer to mere length, or redundancy in the number of joints, which are more usual in very simple and primitive forms of the organ, such as we see in *Blatta*, but of a high degree of specialization, testified by large lamellar plates or pectination. Whether the eye is developed at the expense of the antenna, and is so to speak the receptacle of all the vital forces of the head, or whether the antenna supplements the loss of the other organ of sense, and is useful in detecting the presence of the female, only one fact is in evidence, which is that this plumosity of the antennæ, in one case, and this enormous development of the eye in the other, are usually sexual characters predominating in the male, but sometimes found in both sexes.

In support of his view Mr. Gorham exhibited a selection of species arranged in three groups, viz.:—

i. Species with plumose antennæ, small or moderate eyes, both sexes winged, light-emitting surface confined to one or more small spots:—*Lamprocera*, *Cladodes*, *Vesta*, *Lucidora*, *Phænolis*, and *Megalophthalmus.*

ii. Species in which both sexes are winged; light emitted considerable, sometimes greater in the ♀; eyes large, sometimes excessive; antennæ simple, usually filiform:—*Cratomorphus*, *Lucernula*, *Aspidosoma*, *Luciola*, and *Photuris*.

iii. Species in which the female is apterous or with rudimentary wings; light emitted often very great in the female, and often only rudimentary traces of it in the male; antennæ usually rudimentary; eyes large in the male, often excessively so, occupying nearly the whole head:—*Pleotomus*, *Lamprophorus*, *Microphotus*, *Lampyris*, and *Lamprorhiza*.

In the discussion * which followed the paper, the author, in reply to a question how he had determined the intensity of the light without actual photometric measurement of the live insects, stated that the light-emitting segments at the extremity of the abdomen were distinguishable by their white, vitreous appearance, and that he considered their number and size to indicate the phosphorescent power. He did not consider that these vitreous segments were themselves luminous, but that the source of light was within the body of the insect, and shone through the transparent segments, or could be withdrawn at pleasure. In this manner he thought the gradual extinction or intermittent flashing of the light might be explained.

**Influence of Temperature in producing Varieties of Lepidoptera.**†—G. Dorfmeister has observed a specimen of *Vanessa Atalanta*, stated to have been bred from a pupa of the year before, with the lower side of the hind wings buff-coloured; he therefore made experiments to test the cause of this by trying to breed similar forms, and succeeded in producing just such a specimen as the first. As the species does not naturally pass the winter in the pupa state in this part of the world, many pupæ were killed by cold, and the temperature at which they thrive was discovered in the course of the experiments. The variety mentioned was obtained among the imagos from pupæ which had become pupæ at 10° to 11° R., and were afterwards kept at $7\frac{1}{2}$° to $5\frac{1}{2}$° R., and some varieties resembling it resulted from the same treatment; pupæ, however, kept at from 1° to 2° R. either died or furnished crippled imagos.

Using higher temperatures, and forcing the pupæ in a shorter time, he found that several similar varieties were produced, the method being to allow the pupation of the caterpillars to take place between $7\frac{1}{2}$° and 11° R., to keep the pupæ from three to seven days at the same temperature, and for the remaining eighteen to thirty days to keep them in a room of sometimes tolerably low temperature.

With *Vanessa urticæ* he found that diminishing the warmth produced stages of transition to the Lapland form. *Vanessa levana*, however, which is accustomed to pass the winter as pupa, developed no varieties when exposed to a greatly diminished temperature.

In order to determine the exact period at which the future colourings and markings are fixed on the insect, he recalls the fact

* Ibid. (Proc.), p. vi.

† 'MT. Naturw. Ver. Steiermark' (1880), Abhandl., p. 3, 1 plate.

that the most extreme varieties resulted from larvæ which had been kept in the cellar (i. e. at a low temperature) during their period of pupation; but from his other experiments, and from some recorded by Professor Weissmann, he is now inclined to believe that this critical period occurs, not at the time of the pupation itself, but immediately after it.

With regard to the known sensitiveness of Lepidoptera to low temperatures while entering the pupa stage, he states that larvæ of *Arctia caja* need at least 9° to 10° R. for this operation; some kept at a degree varying between 8° and 10° took from twenty-four to thirty days to make the change after spinning up, and then only produced somewhat deformed imagos; those kept below that temperature perished.

**Protective Attitude of the Caterpillar of the Lobster Moth.***— Most entomologists have admitted that the grotesque attitude of those caterpillars forming Newman's "Cuspidate" group was in some way protective, but it is only quite recently that Dr. Hermann Müller has made known the results of his observations on the caterpillar of *Stauropus Fagi*, which observations now for the first time tend to show the true meaning of this attitude in the species in question.

When sitting on a twig in its natural position the head and first five segments are held erect, and the greatly lengthened legs of the second and third segments held outstretched; thus, when seen from the front, the whole aspect of the insect, both in form and colour, is most spider-like, and when alarmed it immediately raises its four long legs and moves them irregularly, after the manner of a spider attacking its victim. This spider-like appearance is believed to be a special protection against ichneumons which may approach it from the front. According to the experience of H. Müller ichneumons are especially afraid of spiders, and he states, on the authority of Fleddermann, an experienced breeder of insects, that the larva of *S. Fagi* was never found to be attacked by ichneumons, whilst, according to Treitschke, the nearly allied *Hybocampa Milhauseri* is often attacked by them, although a much rarer species, which rarity may perhaps be attributable to the complete absence of such protection as that possessed by *S. Fagi*.

So much for the front aspect of the caterpillar under consideration. When approached from the rear there is nothing to be seen but the erect, hard shield-like surface of the last segment surmounted by two black horns, and presenting an appearance totally unlike that of a caterpillar. When a side view of the larva is presented, there is seen on the fourth and fifth segments a small black depression just below the spiracles, and giving the appearance of a caterpillar *which has been stung by an ichneumon*, so that one of these foes approaching from the side would be deceived and abandon it without depositing its eggs.

**Odoriferous Apparatus of Sphinx ligustri.**† — This has been lately discovered by Von Reichenau, who found, while stuffing the

* 'Kosmos,' 1879, p. 123. See 'Trans. Entom. Soc. Lond.,' 1880, 'Proc.,' p. iii.
† 'Entomol. Nachr.,' vi. (1880) p. 141.

abdomen, a bunch of colourless hair-like scales lying in a fold on each side of the first abdominal segment; it could be extruded from the fold by pressure. The aperture has the form of a cylindrical tube, and here a strong musky scent was perceptible, and did not occur elsewhere. The scales are readily visible with the naked eye.

**Spinning Organs of Insect Larvæ.***—Dr. Gustav Joseph has a preliminary communication on these organs. He finds, in opposition to Lidth de Jeude, that they are supplied with nerves from the sub-œsophageal ganglia and from the gastric nervous system. When the integument is carefully removed from young larvæ in which the fatty body is but slightly developed, it may be seen that between the peritoneal investment of the spinning tube and its glandular cell-layer there is a distinct nervous plexus formed of extremely fine dichotomous filaments which pass in between the gland-cells.

These spinning organs are developed very early in the course of existence, and commence as a small depression; this gradually deepens and becomes converted into a tube; the cells which bound its lumen are at first scarcely to be distinguished from the morphological elements which make up the outermost layer of the general integument. These tubules generally make their appearance before the salivary glands, but this is not always the case. The author, in opposition to Hatschek, would regard them as being tegumentary glands, or in other words as being primarily differentiated from the integument. They are not to be confounded with the salivary glands, the function of which is in relation to the ingested nutriment; and they themselves demonstrate their relations to the integument by forming a secretion which hardens on exposure to the air, and has some of the characters of a cuticle.

As is briefly pointed out, the development of the three constituent parts of the tube—gland, reservoir, and efferent duct—differs in different species. Further details are promised.

**Parthenogenesis in Halictus.**†—The observations of M. Fabre have been chiefly made on *Halictus cylindricus* and *H. sexcinctus.* After a description of the conditions under which he observed the two species, the author points out that for this genus there is no "society" in the entomological sense of the word; each mother cares only for its own larvæ, though the various parents unite to form a common home; each cell in the gallery is nevertheless the property of a single *Halictus*. As to the relations of the sexes, we find that males are very rarely to be detected; in September, however, they are to be found in quantity. Beginning, then, with the month of November, we find females which have evidently been fertilized; this is easy to understand, but at this period the males have completely disappeared. The females pass the winter in their cells, and towards May they come out and work at their nests. In July, though no males have yet been seen, there is a second generation; but here

* 'Zool. Anzeig.,' iii. (1880) p. 326.
† 'Ann. Sci. Nat.,' ix. (1880) Art. 4.

comes the difficulty, that we know that the females die down after having taken steps for the continuance of the race; and again, what have become of the numerous females developed in May, if it is really true that the presence of the males is necessary for the formation of ova capable of development? "They are mothers, and fertile mothers, without having known the male." The generation in July is therefore a true case of parthenogenesis. The results of these ova are male and female, and the members of the former sex are in greater abundance. Excepting the Aphides, this would appear to be the first well-authenticated case of the alternate development of fertilized and of non-fertilized ova among the Insecta; the cases of Lepidoptera which might be brought to bear upon the point are sporadic and accidental.

The author concludes with a notice of a parasite on *H. sexcinctus*, which is the larva of *Myiodytes subdipterus*, a coleopteron with greatly reduced elytra. As soon as the larva of *Halictus* has swallowed its honey, it is devoured by *Myiodytes;* as to the deposition of the ova of this last, the author has at present nothing to communicate.

**Galls produced by Aphides.***—In this paper M. Courchet deals with the principal galls produced by aphides, from the triple point of view of their development, their morphological value, and their structure.

He abstains from discussing the action that the puncture exercises on the vegetable tissues; but he points out that if mechanical influence could take any part whatever in the formation of galls it would certainly be in those of the aphides, the insect being always alive and active in the heart of the new tissues. Further, the action of the animal poison, to which, according to M. Lacaze-Duthiers and others is attributed the production of the galls, is not absolutely comparable to that of a virus on animal tissues; the latter has no need to be inoculated and incessantly renewed to give rise to the production of special phenomena, whilst M. Courchet has always observed that the galls (of aphides), which for any cause have been abandoned by their inhabitants, are arrested in their growth.

M. Courchet passes in review the galls of the Terebinth, the Lentisk, the Black Poplar, and the Elm, dwelling particularly on the first three, which are the most interesting and the least studied.

Of the Terebinth, five galls are described: *horn galls* (galle en corne), produced by *Pemphigus cornicularius*, and *utricular galls* by *P. utricularius*, both formed at the expense of the tissues of the median nervure. The three others are formed by the lamina of the leaf folded in different ways, and are the production of *P. pallidus*, *P. follicularius*, and *P. semilunarius*.

On the Lentisk is found one gall, produced by an *Aploneura*, and which is similar to those of *P. pallidus* and *P. follicularius*.

The Black Poplar has six galls; one formed at the expense of the tissues of a branch, the others being of a foliar nature. They are

* 'Rev. Sci. Nat.,' i. (1880) pp. 533–41.

produced by the following insects: *P. spirothecæ* (gall formed of the twisted petiole), *Pachypappa marsupialis* (gall in the form of a purse, generally red and compressed laterally, projecting from the upper side of the leaf). *Pemphigus bursarius* (gall growing either on a branch or a petiole), *P. populi* n. sp. (gall insufficiently studied, but it is believed that the tissues of the median nervure take the greatest part in its constitution), *P. affinis* (hardly to be considered a "gall," consisting simply of a folding of the leaf on the median nervure, the right and left margins meeting and forming a large cavity between the two parts of the leaf), *P. vesicarius* (gall possibly resulting from the union and abnormal growth of the leaves of a bud).

The following are M. Courchet's conclusions:—

1st. None of the galls produced by the aphides arise from the very centre of the tissues of an organ; some commence by a simple invagination of the lamina of a leaf ("horn gall," utriculate gall of the Terebinth), or by a cellular swelling which forms and rises little by little around the insect as in the gall of *Pemphigus bursarius* of the Black Poplar; or again, a petiole coiled up on itself encloses the insect in a cellular utricle which finally becomes a true gall, as happens in the case of *P. spirothecæ*, &c.; in other words, all may be classed under M. de Lacaze-Duthiers' term of "false internal galls."

2nd. Their cavity is always spacious, and the wall relatively thin, which is rendered necessary by the presence in their interior of an always considerable number of living insects.

3rd. Their structure always retains more or less of that of the organ which bears them, and which is entirely, or in part, transformed to produce them. In general their walls are composed of a tolerably homogeneous fundamental cellular tissue, which is traversed by fibro-vascular bundles in variable number. There are no well-marked concentric layers here, as seen, for instance, in the galls produced by *Cynips* on the oak.

4th. All the galls of aphides hitherto observed by the author, with one exception, represent appendicular organs, or parts of appendicular organs transformed; the gall of *Pemphigus bursarius* alone is formed laterally on an axis or petiole by a single proliferation of the herbaceous layer, and in an independent manner.

### β. Myriapoda.

**Eyes and Brain of Cermatia forceps.***—Mr. N. Mason has made preparations of the eyes of this Myriapod, which is useful as a spider-destroyer, and Dr. Packard gives the result of his examination of the eyes and brain.

The eye appears to be constructed on the same plan as that of other species of the sub-class, but differing in important respects. Though *Cermatia* is said to have compound eyes in contradistinction from the so-called "ocelli" of other Myriapods, the latter are likewise truly aggregated or compound, the "ocelli" being composed of contiguous facets, the nerve-fibres supplying them arising in the

* 'Am. Nat.,' xiv. (1880) p. 602.

same general manner from the optic nerve as in *Cermatia*, where the facets are much more numerous. The eye of *Cermatia* is composed of a hemispherical, many-facetted cornea, the lenses of which are shallow, doubly convex, being quite regularly lenticular, the chitinous substance being laminated as usual. Each corneal lens is underlaid by a retina about as thick as the cornea, the inner surface of each retinal mass being convex. Corresponding to each lens is a separate mass of connective tissue, which increases in thickness from the end of the optic nerve outward towards the cornea; though the entire retina of the eye extends back to the *ganglion opticum*. Within the broad stratum of connective tissue, forming the entire retina of the eye, lies next to the corneal lens a layer of "vitreous cells" or "lens-epithelium" of Graber. This layer is succeeded by the series of rather large visual rods, one in each mass corresponding to each corneal lens; these rods are long and sharp, conical at the end which extends nearly to the inner edge of the retinal mass; they each possess a nucleus, and the connective tissue enveloping the rods is nucleated, while there is an irregular layer of nucleated cells near or around the ends of the rods. There are no cones; these not being yet detected in the eye of Myriapods. This layer of cells is succeeded by a thin, slightly curvilinear, transverse strip of connective tissue passing through the entire eye, and behind it are the loose, nucleated, spherical cells forming the *ganglion opticum*.

The brain of *Cermatia forceps*, as shown by several sections, is developed on the same plan as in *Bothropolys*, and the myriopodan brain seems to correspond more closely in its general form and histology with that of the insects than the Crustacea. The large, thick optic nerve arises from the upper side of each hemisphere. The median furrow above is deep, and on each side is a mass of small ganglion cells; also a mass in the deep fissure below the origin of the optic nerve, and another mass on the inferior lobe extending down each side of the œsophagus, probably near or at the origin of the posterior commissure. These masses, i. e. those on the upper and under side of the brain, connect on each side of the median line, and in this respect the brain is as in *Bothropolys*. There are no large ganglion cells as in Crustacea, including *Limulus*.

There is, then, no very close resemblance in form or histology between the eye and brain of *Limulus* and the Myriapods, the two types of eye being essentially different.

### γ. Arachnida.

**New Work on Parasites.**—M. P. Méquin has just published a work entitled 'Les Parasites et les Maladies Parasitaires.' The part which has already appeared deals with the parasitic Arthropoda. In addition to the sixty-three woodcuts which are intercalated in the text, there is a separate atlas of twenty-six plates. This work ought to be useful as a dictionary and handbook of the characters of the more important Arthropod parasites, for though not without faults it goes a long way to supply a want which has been long felt.

**New Galeodida.***—In his latest contribution to this subject, Dr. Karsch describes a number of new forms, and among these there are three new genera—*Zerbina* (*Z. gracilis* C. L. Koch), *Dæsia* (*D. præcox* C. L. Koch), *Biton* (*B. Ehrenbergii* n. sp.), and *Gnosippus* (*G. Klunzingeri* n. sp.). The author is of opinion that the time has not yet come for a natural arrangement of this group. Simon, in rejecting what he regards as Koch's artificial arrangement, has left equally important points out of consideration. In proof of his position the author gives an interesting table showing the number of tarsal joints in the three hinder pairs of legs in the genera of the Galeodida, which shows up the lacunæ in our knowledge in a very striking manner.

### δ. Crustacea.

**Antennary Gland of the Crustacea.**†—In this important essay Dr. Grobben commences with an account of his observations on some of the Phyllopoda; in the larvæ of *Estheria* and *Branchipus* he has found that in its early condition the gland consists of two parts, histologically different; there is a terminal saccule, and a urinary canal, looped and coiled. The former lies between the muscles of the second antenna and has a dorso-ventral direction; it is attached to the integument by connective fibres. The canal extends from before backwards, and opens at the base of the second antenna. The saccule is lined by an epithelial layer lying on a delicate supporting membrane; the cell-protoplasm is clear, rich in vacuoles and numerous yellowish-brown granules. In the canal we only find three nuclei, so that its walls are formed by three cells; the protoplasmic granules are principally arranged in cords, while on the internal surface the cells are invested by a rather thick cuticle.

In the Nauplius form of *Cetochilus helgolandicus* the canal is formed by a few cells, the terminal saccule by a single one, and it is provided on its inner surface with a delicate cuticle. In *Cyclops* (Nauplius form) the antennary gland is considerably elongated, the canal is long, curved dorsally, and after a complex course returns to the region of the saccule.

Turning from the Entomostraca to the Malacostraca, the author describes what he has seen in *Gammarus marinus*; here, again, there is a terminal saccule and a canal; the former, reniform in shape, lies near the integument, and the canal after several coils returns to open near it. The protoplasm in the cells of the former is coarsely granular, and in the latter finely fibrillated; its terminal portion has special cells, which completely resemble the matrix-cells of the integument, and they shed out a chitinous cuticle; to this portion of the "urinary canal" the author applies the term of "ureter."

After giving a description of the same parts in *Mysis*, Dr. Grobben comes to the so-called "green gland" of the Decapoda; in *Palæmon treillianus* the gland lies in the basal joint of the second antenna; the saccule is reniform and is supplied by a large blood-vessel; the whole course of the canal was not exactly followed, and

* 'Arch. für Naturg.,' xlvi. (1880) p. 228.
† 'Claus's Arbeiten,' iii. (1880) p. 93.

it will be useless here to describe the numerous loops that it makes. As to the minuter details, we are told that the saccule is not a simple sac with smooth walls, but that it consists of a large number of cæcal sacs, between which there is a rich network of connective tissue, in the lacunæ of which the blood can freely circulate. The cells have large nuclei, and pale, finely granular contents; on the other hand, in the canal the cell-contents are arranged cord-wise, and are best developed on the side of the cell most distant from the lumen. The thick cuticle is likewise striated, and in a direction perpendicular to the axis of the canal. The results of his observations on the green gland of *Astacus fluviatilis* do not altogether agree with those of previous observers; forming a compact mass, lying largely in the thorax, the saccule and canal are still to be distinguished; the former is rounded, and of a yellowish-green colour; the canal is delicate, provided with diverticula, and extended into a wide canal of a pale greenish-grey colour, which has similar diverticula, and which lies coiled between the saccule and the green part of the canal; the terminal portion of the duct is here again lined by a chitinous cuticle. Deep clefts are to be observed between the epithelial cells of the saccule, and the protoplasm is seen to contain a number of amorphous yellow-green bodies; the bright-green portion of the canal has epithelial cells of a cubical or cylindrical form, and the contained granules are arranged cord-wise; there is a thickish cuticle, thinner at certain points, and so, in optical section, appearing as though it were composed of rods. The author insists on the rich supply of blood-vessels to all parts of the canal.

When we compare these results with what we know of the shell-gland, we find a striking resemblance in structure; without going here into this subject in detail, attention may be directed to the conclusion that the two glands have a similar structure; further, the view that they are homologous is supported by the fact that they are both mesodermal in origin. As to the functions of the parts, it would seem that the terminal saccule is to be compared to the Malpighian capsules of the Vertebrate kidney; while the canals are comparable to the *tubuli contorti*.

In both Vermes and Mollusca the urinary canals are formed by a few cells, and the difference in the length of the canal in *Cyclops* as compared with *Cetochilus* is to be explained by the fact that one inhabits fresh and the other salt water, just as the marine Polychæta have short, and the fresh-water Oligochæta long segmental organs.

**Rapidity of the Transmission of Motor Stimuli along the Nerves of the Lobster.***—MM. Frédéricq and Vandevelde find that at Ghent, at a temperature of 10–12° C. (in February and March), this rapidity was about 6 metres a second; at Roscoff, with the temperature at from 18–20° C. they attained different results, the rapidity being from 10–12 metres a second. Both these data show that in the lobster stimuli are conveyed along motor nerves very much more slowly than they are along those of the frog or of man.

* 'Comptes Rendus,' xci. (1880) p. 239.

**Nervous System of Idotea entomon.*** — This Isopod, selected for study by M. Ed. Brandt, has three cephalic, seven thoracico-abdominal, and four post-abdominal nerve ganglia. Of the cephalic group, the supra-œsophageal (not that so called by Rathke, which is the sub-œsophageal) is made up of two median lobes, the hemispheres, sending nerves to the interior antennæ; of two external, the optic, lobes, giving off the optic nerves; and of two antennary lobes supplying the external antennæ. The short and very thick œsophageal collar gives off two nerves to the labrum. The sub-œsophageal ganglion is small, and, as in insects, gives off three nerve pairs, to the labium, maxillæ, and mandibles respectively. The third cephalic mass, for which the name *pedomaxillary* is proposed, rests on a special pedomaxillary plate, and from it proceeds one pair of nerves, similarly named, to the two maxillipedes. Of the ganglia of the main body, the first is small, but larger than the pedomaxillary, and all the rest are of one size; from each of them originates a nerve pair to the feet, while the commissures between them supply the muscles and integument of the segment. The pedomaxillary shows the same arrangement, sending off nerves to the posterior part of the head as well as those for the maxillipedes. It would seem from its innervation and the presence in it of a distinct ganglion that the posterior part of the head is a thoracic segment amalgamated with the head. The latter therefore forms part of an imperfect cephalothorax, but is still morphologically different from the heads of insects.

The four post-abdominal ganglia are much smaller than those of the body; the three anterior are all of the same size, and give off each a single nerve pair to their segments; the fourth is larger, and four pairs of nerves proceed from it. An azygos sympathetic trunk lies here between the commissural cords of the central system, and is interrupted by ganglia as already described by F. Leydig in *Porcellio scaber*.

**Cymothoidæ.**†—A year or two ago a request was sent to the various museums of the world by Drs. Schiödte and Meinert, of Copenhagen, requesting the loan of all specimens of Cymothoidæ (Isopoda) for the purpose of monographing the group, and the first portions of the monograph have now appeared.

The first of these papers treats of the Cirolanidæ, which closely resemble the true Cymothoas, but which differ in having the mouth-parts adapted for eating flesh. Three genera and nine species are characterized, of which the genera *Barybrotes* and *Tachæa*, and species *B. indus*, *B. agilis*, *T. crassipes*, *Corallana collaris*, *brevipes*, *nodosa*, and *hirsuta* are new. Each species is described, as far as the specimens permitted, under three heads—male, virgin, and ovigerous females—the difference between the sexes and between the two forms of the same sex being very striking.

In the second paper the Ægidæ are monographed. These Crustacea lead a parasitic life, generally attaching themselves to the

* 'Comptes Rendus,' xc. (1880) p. 713.

† 'Nat. Tidsk.,' xii. pp. 279 and 321. See 'Am. Nat.,' xiv. (1880) p. 519.

roof of the mouth of fishes, and with their modified mouth-parts, which form a sucking tube, living on the blood of their hosts. These forms are described under the following generic and specific names, those marked (*) being new:—*Æga tridens, hirsuta,* crenulata, Webbii, Strœmii, rosacea, serripes, psora, Deshayesiana, antillensis,* magnifica, monophthalma, nodosa,* ophthalmica, tenuipes,* dentata,* incisa,* arctica, ventrosa* and *spongiophila, Rocinela danmoniensis, insularis,* Dumerilii, maculata,* americana,* orientalis,* australis,* signata* * and *aries,* Alitropus typus* and *foveolatus.** Full descriptions are given of the male, virgin, ovigerous female, and the young. The text is in Latin, and there are plates.

**Ostracoda of Scotland.***—The Natural History Society of Glasgow are publishing catalogues of the fauna of Scotland, with special reference to Clydesdale and the western district, and amongst them is one on the fresh and brackish-water species of Ostracoda by Mr. D. Robertson.

Forty-one species are given, of which three are new (*Cypris granulata, Candona euplectella,* and *C. nitens*).

Those which may be considered to belong exclusively to brackish water, but never by choice to be purely marine, are *Cypris salina, Cypridopsis aculeata, Cytheridea torosa,* and its variety *teres*. *Cypris incongruens* and *Cypridopsis obesa* are frequently found in brackish water, but as frequently in purely fresh water.

Many other species are occasionally met with in water more or less brackish, as in ponds a little above high-water mark, subject to the spray of the sea during high tides and storms, but chiefly in fresh water quite beyond the reach of marine influences. Reference is made to a group of small ponds lying mostly within a few yards of each other along the south-west shore of the island of Cumbræ, only a little above high-water mark. These appear to be subject to an equal amount of sea-spray, and to be exposed to similar conditions, yet their microscopic fauna are found, when compared, to differ widely. A list of the Ostracoda found in ten of these sub-brackish patches of water shows the great number of reputed fresh-water species associated with those which constantly affect brackish water, and also the diversity in the numbers and grouping of species existing between one pond and another. This mixture of fresh and brackish-water species is all the more remarkable, as none of these ponds communicate with the others, nor with any fresh-water stream.

The author indicates (1) where the Ostracoda are principally to be found, (2) what season of the year is most favourable, (3) by what means secured, and (4) how to preserve them. We can only give a very condensed statement of the author's views on these points, and the original paper should be referred to.

The *places where to be found* are lakes, tarns, ponds, lagoons, canals, ditches, and often in very small patches of water, and in slow-running streams; but in the latter by no means commonly,

* Appended to part 1 of 'Proc. Nat. Hist. Soc. Glasgow,' iv. (1880) (separate title-page and paging).

except in weedy recesses protected from the currents, or where clumps of thickly growing plants abound. They are more abundant in the smaller ponds overgrown with weeds than in deep and large sheets of water. Even in damp mud, and in the scanty water of furrows in old pasture land, good gatherings are met with. Where the pools are small and subject to be dried up during summer, they seldom contain many species, although in such cases one species may prevail greatly. Limestone districts are favourable to Ostracoda, but all rock or clay surfaces are better than peat. Where there is nothing but pure peat, or peaty ponds fringed with *Sphagnum*, few or no Ostracoda may be expected. They are seldom searched for successfully where the lakes or pools have risen much by heavy rainfalls, nor in mill-dams, where the water is drained off rapidly, leaving broad, bare margins. It is otherwise where the water in the pools is decreasing gradually by evaporation. Then the animals appear to have time to follow the water, and may be taken abundantly when thus brought closer together in the small shallow pools left here and there. Moorland roadside ditches are more promising than those at some distance from the road. This may arise from a supply of material from the drainage of the road, which may be requisite to build up the shells of these minute crustaceans. They are seldom absent in ditches or marshes which contain a little ochreous deposit with a metallic bluish scum on the surface of the water; they are more common in broad shallow ditches than in those more narrow and deep, and are rarely met with in springs or in ponds abounding with fish. Neither do they thrive where Amphipods prevail. They are not always fastidious in their choice of habitat, sometimes disporting in pure fresh water, at other times revelling in water of very questionable character; while others affect brackish water, although they live in very different degrees of the saline element.

The best *time for collecting* is of course the summer, during sunshine. Heat is conducive to their increase and development. In a hot-house tank at 65° F., *Cypris incongruens* abounded, but in water from the same source at a lower temperature there were comparatively few. Dr. G. S. Brady found them in mill cooling ponds at 100° F. They may be found, however, under the ice in winter.

The preferable *mode of collection* is a net 6 inches (rather than 10 inches) in diameter and 24 inches deep—the mesh one hundred threads to the inch. This smaller size of net has the great advantage of admitting conveniently a brass wire sieve with a hoop about an inch deep to fit into the ring of the muslin net, preventing weeds and other coarse material from getting into the bag, but sufficiently open to allow all the Microzoa to pass through. A sieve with a $\frac{1}{4}$-inch mesh is very suitable. This protecting sieve requires to be fitted together into the mouth of the muslin net, so as not to fall out when working, but sufficiently easy to be taken off when the contents of the bag are turned out. For security, it is better to have the sieve slung to the neck of the handle by a short cord.

To work the net, simply sweep it through the vegetation along the margin of the pond; this done, remove the sieve, invert the bag, and convey the contents into a wide-mouthed bottle, &c., which will, in most cases, indicate whether there is anything worth further trial, though it often happens that repeated trials afford good results in the same place where they had failed to be seen by the first inspection. The Ostracoda generally withdraw within their shells and become motionless when alarmed, and are difficult to be seen in this state among the debris of the gathering; but where they do exist, more or less of them come to the surface, and are readily detected in an open vessel, but equally as well and more easily by examining the contents of the net when the water is well pressed out. To have the full benefit of the gathering, it is necessary to take some of the mud, which in most cases can be readily procured by scraping the sides or bottom of the pool with the ring of the net.

The *mode of preservation* is shortly dealt with, as Ostracoda require no special appliances for preservation so far as the shell is concerned, further than allowing them to dry; but when the animals are wished to be preserved, alcohol, with the addition of a little glycerine, is preferable.

**Blind Crustacean.*** — M. A. Milne-Edwards has a note on a blind species of the genus *Nephropsis* which was found at a depth of 1500 metres in the Gulf of Florida. The eyes, which are situated just above the internal antennæ, form small tubercles without corneæ; so far the species (*N. Agassizii*) resembles the *N. Stewarti* described by Wood-Mason, but it differs from it in the greater development of the rostrum which is armed with two pairs of lateral spines, by the number of tubercles on its carapace, and by the form of the first five abdominal rings. From the extremity of the rostrum to the end of the tail the new species measures ·055 metre; the integument is completely colourless.

### Vermes.

**Annelids of the Norwegian North Sea Expedition.†**—Fifty-five species are enumerated by G. A. Hansen from the collections obtained by this expedition, among which there are 4 new species of *Polynoë* (*P. assimilis*, *spinulosa*, *foraminifera*, and *glaberrima*), a new *Phyllodoce* (*P. arctica*), a new *Brada* (*B. granulosa*), and three new *Trophoniæ* (*arctica*, *borealis*, *rugosa*), in all 9 new forms out of the 55. *Spinther arcticus* is figured, apparently for the first time. *Polynoë glaberrima* bears much resemblance to *Lænilla glabra* Ingr., but the palps are quite smooth, the tentacular cirrhi are shorter than the palps; instead of two bristles at the base of the tentacles, a single spine occurs. The new species of *Phyllodoce* bears most resemblance to *P. mucosa*, differing from it chiefly in the number of the papillæ on its prostomium.

**New Genus of the Archiannelides.‡**—Under the name of *Protodrilus Leuckarti*, Dr. Hatschek describes an interesting new form which he found near Messina. As it is more simple even than *Poly-*

* 'Ann. Sci. Nat.,' ix. (1880), Art. 2.
† 'Nyt Mag. Naturvid.,' xxv. (1880) p. 224 (5 plates).
‡ 'Claus's Arbeiten,' iii. (1880) p. 79.

*gordius* it is almost certain that it is the very lowest of all known Annelides; the points in which it is lower affect chiefly the organization of the nervous system, the characters of the ventral ciliary groove, the blood-vascular system, and the relations of the midgut.

These little worms ("Wurmchen") are of yellowish-white colour, and the sexually mature individuals are about 4 mm. in length; they creep about like Nemertines, and locomotion is principally effected by cilia, while the direction they take appears to be influenced by the longitudinal muscles of the body. Their general appearance is very much that of *Polygordius*, the elongated body exhibits no external segmentation, the ventral surface is rather flattened, and along the trunk there is a deep ciliated groove. The cephalic portion, which is somewhat thicker, has two flattened contractile tentacles at its anterior end; the hinder end is narrower and notched. Segmentation is expressed by the five boundary lines in the ectoderm, by the ciliation, as well as by the dissepiments and the segmental organs.

The cephalic region is distinguished by the possession of a very large post-oral region, similar to that observed in *Polygordius* and *Saccocirrus*. The number of trunk-segments increases during the maturation of the generative products; 22–31 segments were counted. The last segments of all are always very small, and but imperfectly differentiated in their histological details.

As in the allied forms, the epidermis, the nervous system, and the sensory organs stand in closer relations to one another than they do in the more differentiated forms; the epidermis is largely composed of cubical cells, and a definite cuticle can hardly be made out; between these cells there are club-like mucous cells, opening to the exterior by a fine orifice; the cilia form, for the greater part, circlets, and of these we find a double one in front of and a single one behind the mouth; while on the post-oral cephalic region there are four circlets. On the trunk-segments there is anteriorly and posteriorly another circlet, but the cilia are delicate and sparsely distributed. The sensory hairs are especially numerous on the tentacles, the anterior end, and on the posterior segments, and there is also a better developed one on the two terminal processes.

The nervous system is difficult to make out in the living object, the ganglionic nature of the frontal ganglion being indistinguishable, and the presence of the organ merely indicated as a thickening of the integument; the sensory organs are represented by two transverse, elongated, ciliated slits, placed on the dorsal surface of the anterior portion of the head. There are no pigmented eyes. Transverse sections of specimens, suitably hardened and prepared, reveal a number of other facts. The apparently sensory bodies connected with the frontal plate are seen to consist of a number of cells ranged round a central point; the inner part of the frontal ganglion is formed of a largish mass of nerve-fibre; the neighbouring epithelium is considerably thickened, but the cells are really all arranged in a single layer. Just in front of the mouth the fibrous cord bifurcates to become connected with the lateral parts of the ventral surface; in the post-oral cephalic region they approximate towards one another. In the first trunk-segment they approach the middle line, and the broad ciliated surface of the cephalic region is converted into a narrow but deep ciliated groove. It was not found possible to detect any peripheral nerves. The muscular system is arranged very much as in *Polygordius.*

The enteric canal extends to the hinder end of the body, but no rectal division could be made out in it. Just behind the mouth there opens into the œsophagus a muscular organ of a complicated form, and terminating blindly in a chitinous vesicle very similar to the same organ in *Polygordius;* it has a function which still remains to be discovered.

In the first trunk-segment there is a broad dorsal vessel, which in the posterior region of the head is enlarged into a contractile bulb; this consists of a simple membrane formed of flat, doubly-granular cells. By rhythmical contractions the bulb drives the colourless blood into a narrow, thin-walled vessel, which reaches as far as the frontal ganglion, and there opens into a transverse branch, which is continued on either side into a tentacular vessel. From the cavity into which these open, the blood is carried away by another thin-walled vessel. A transverse venous plexus is formed behind the frontal ganglion, and from thence two ventral veins pass into an unpaired one. The bulb already mentioned and the arteries of the tentacles are the only parts that are contractile. The dorsal vessel appears to be filled from lacunæ in the enteric walls, and its lumen appears to be a continuation of the cavity within the entero-fibrous layer.

The segmental organs are found in all the fully developed segments, placed in the lateral line, without the peritoneum. They commence by a narrow infundibulum, armed with a long flagellum; the wall of the succeeding portion is filled with granules and provided with delicate cilia; the external orifice is in the lateral line, and pierces the ectoderm.

*Protodrilus*, like some species of *Polygordius*, is hermaphrodite; the ovaries, which consist of very small cells, are found in the seven most anterior trunk-segments; behind these the testes are developed. In some species of *Polygordius* the ovaries as well as the testes are developed in the more posterior segments; this would seem to indicate that primitively all the segments were hermaphrodite.

The author concludes by remarking on the extreme simplicity which may be exhibited within the limits of the Annelid type.

**Enchytræus cavicola.***—This is a new species of a blind worm, described by Dr. G. Joseph, and discovered in a grotto. The greyish-white body has a transparent integument; the cœlom is always in communication with the exterior by means of a *porus cephalicus*, which is placed between the cephalic and oral lobes; the dorsal vessel has a definite wall only in the anterior third of the body; the blood was reddish in colour. The œsophageal ganglionic swelling is reniform in shape, and gives an indication of a commissure by a shallow grove. The orifices of the oviducts are transverse clefts, placed between the

* 'Zool. Anzeig.,' iii. (1880) p. 358.

12–14th rings; the testes are stalked, and the seminal glands have an "amorphous form"; by these two points the new species is distinguished from *Pachydrilus*, while, by the presence of red blood, it is remarkable among other species of *Enchytræus*.

**Batrachobdella Latasti.***—M. Viguier has now published in full his account of the organization of this form (see this Journal, ii. p. 885). The author is of opinion that in it, and doubtless also in *Clepsine* and its allies, the tactile and gustatory sense-organs are to be found in the proboscis, which has a very rich plexus of nerves. There are only two eyes, and these are placed close to one another; they are irregularly quadrangular in form.

The author has some doubt whether the single specimen of *Glossiphonia algira*, which Moquin-Tandon was able to examine, and on which he founded the species, was not really a large *Batrachobdella*. Bearing in mind that the specimens he himself was enabled to examine were not fully mature, and that the two species have the same habits and inhabit both the same region, he concludes by throwing out the suggestion that M. Tandon's form was really a *Batrachobdella*, and that the new specific name of *Latasti* may have to yield to the prior appellation of *algira*.

**The Chætognatha.**†—Oscar Hertwig publishes a monograph of rather more than one hundred pages (and five plates) on these very instructive "worms."

The author commences by directing attention to the deep significance which must be given to the two modes by which various animals develop their cœlom or body-cavity; in the greater number of animals this cœlom is formed by a cleavage of the mesoblast, and to this Professor Huxley has applied the name of *schizocœle;* others, such as the Echinodermata, Brachiopoda, and Amphioxus, together with the Chætognatha, develop their cœlom from outgrowths of the endoblast, and to this form Huxley has given the name of *enterocœle*.

It is now ten years since Kowalevsky placed these differences on the firm ground of observation, but, important as these differences are, they have hitherto been hardly regarded with sufficient attention; to what results they may lead us will be best illustrated by stating at once the general conclusions to which Dr. O. Hertwig has been led.

*Relations of the Chætognatha to the Cœlenterata.*—The Actiniæ by (1) the development of diverticula from the primitive enteron, and (2) the physiological and histological characters of these parts, exhibit many striking relations to the Chætognatha. It is at a very early stage in development that the archenteron of *Sagitta* becomes divided into three cavities, or, in other words, provided with two lateral diverticula; a septum of an Actinian and an endoblastic fold of a Sagitta are comparable structures, inasmuch as both have for

* 'Arch. Zool. exp. et gén.,' viii. (1880) p. 373.
† 'Jen. Zeitschr.,' xiv. (1880) p. 196.

their primary purpose an increase of the internal surface of the enteron. The differences lie in the degree to which the folds or septa are developed. In the Actiniæ there are a number of them, and they are arranged radially around the enteric axis; in the Chætognatha there are only two, and these two are arranged in a bilaterally symmetrical fashion, while, instead of continuing to project into the enteron by their free edges, they become shut off from it and converted into two closed sacs.

Passing to the question of their functions, we find both in the Actiniæ and in the Chætognatha that the generative organs and the musculature of the body are developed from the endoblast; the development of the nervous system has, moreover, probably, though not certainly, exactly the same history in both these groups.

Striking as these resemblances are, they are not sufficient to justify us in affirming any closer relation of these two divisions than is as yet allowed; all that we see is that there is in the development of organisms certain fundamental laws which are obeyed by different animals; and the work on which Hertwig is here engaged is the study of the laws of the formation of organs and of tissues.

*The Chætognatha and the other Worms.*—The Chætognatha seem, as other naturalists have already noted, to be most nearly allied to the Nematoids and Annelids; with the former the most important resemblances lie in the fact that in many of them (Gordiacea) the enteric canal is attached to the dermo-muscular tube by a dorsal and ventral mesentery: together with other points, we have to note that in other Nematoids the muscles form plates which are set perpendicularly to the surface of the body, and are made up of parallel fibrils. The relations of *Sagitta* to the Annelids is still more remarkable; if we make a transverse section through a *Sagitta* and compare it with a somewhat old larval stage of *Polygordius*, we find that in both cases the enteron is invested in a fibrous enteric layer, and is attached by mesenteries, which completely divide the cœlom into a right and left half. In both cases there are four bands of longitudinal muscular fibres, the cells of which are derived from the cœlomatic surface. Points of resemblance to *Spadella cephaloptera* are to be observed in the development of transverse muscular fibres on the inner side of the ventral muscular bands and in the minute structure of the fibres. The two transverse septa of the Chætognatha are comparable to the numerous transverse septa in Annelids, while, lastly, in both groups the generative products are derived from cells of the parietal layer of the mesoderm.

Are these resemblances analogical or homological? To answer this question we must first answer these others. Has the mesoblast been formed by the development of folds or by the differentiation of cells? Is the cœlom an enterocœle or a schizocœle? These are the questions which the author is anxious to bring to the fore, and, until they are answered, we cannot speak confidently as to either the systematic position of the Chætognatha, or as to that of other phyla and divisions.

We must deal briefly with the details of the anatomy and histology of the Chætognatha, on which Dr. Hertwig's general conclusions are based.

The more or less cylindrically shaped body of the Chætognatha is distinguished from that of all other Vermes by the possession of lateral fin-like appendages, and by the special armature of its head. The lateral fins vary in number and character in different species, but the unpaired caudal fin is always constant; this latter has a general resemblance to that of fishes, but differs from it in being horizontal and not vertical. The special armature which gives the name to the group may be regarded as consisting of (1) spines or (2) prehensile hooks; the former are small, straight, and conical, and are arranged in 2–4 rows around the mouth. The latter, of which there are only from 8–10, are very much longer, sickle-shaped, and with a sharp point. Connected with these organs is the special and characteristic apparatus to which Krohn gave the name of cephalic cap. This consists of two thin folds of integument, which arise on the dorsal side of the head, and thence pass on to the ventral surface. The cœlom varies in capacity according to the size of the species, but is always divided by two thin transverse folds into three parts or segments, which may be respectively denominated the head, trunk, and tail segments.

The enteric canal takes a straight course through the body; the mouth is a longitudinal cleft about half as long as the head; in the tail segment the enteron is represented by a caudal septum which divides the cavity into a right and left portion. There are no kidneys, heart, or blood-vessels; each individual is provided with two ovaries and two testes; the former occupy nearly the whole of the trunk-segment, while the latter are developed in the walls of the cavity of the caudal region; one segment is, therefore, male, and another female.

Of the external structures we can only notice the fins and the glandular cells. The fins are reported to be made up of a gelatinous supporting substance, of homogeneous filaments, and of an epidermal investment. The first of these is completely structureless and devoid of cells; its flat surface is covered by the homogeneous filaments, which are closely applied to one another and end in a fine point; in transverse section they are semicircular, and may be seen to be made up of a firm structureless substance, in which no distinct cells can be made out in the adult. The epidermis is formed by a single layer of thin flattened cells.

The glandular cells were only observed in one species, *Spadella cephaloptera*. Lamellar in form, and from three to five in number, they are arranged in rosette shape around a central point, so that they seem to be organs of attachment. They give a "warty" appearance to the ventral surface, on which alone they are developed; they are most common near the tail, and become rarer and smaller as we approach the head. The constituent cells are either cubical or cylindrical in form.

The *sensory organs* are either tactile, optic, or olfactory, but in all cases they retain their relations to the ectoderm. The first of these form small elevations, provided with stiff tactile setæ; they may be arranged indefinitely, or, as in a small Sagitta observed by Langerhans, they may be arranged by sixes in forty rings. The eyes are found on the upper surface of the head, and form two blackish spots of so small a size as to be indistinguishable to the naked eye. When magnified, the eyes are seen to be formed by spheres, made up of small cells, which are enclosed by the usual transparent epidermis, and are sharply separated off from that layer; the part exposed to the light is coloured by a blackish pigment and contains a transparent lens; these last two structures are surrounded by a circlet of numerous, highly refractive rods; the form of these rods is highly characteristic. The end which is approximated to the pigment and lens is thin and cut short along a transverse axis; the rods then thicken somewhat, but suddenly diminish in width towards their tip. Still further and closer examination leads to the conclusion that the eye of the Chætognatha is not a simple but a complex structure, affording many points of resemblance to the same organ in the Crustacea; there are three lenses, and it is clear that the eye is made up by the fusion of three simple *ocelli*. The "optic epithelium" consists of a rod and a layer of granules, which are sharply distinguished from one another. The organ is completely enclosed in the epidermis, and is invested on its outer face by a thin layer of flattened epidermic cells.

The *olfactory organ* does not seem to have been hitherto correctly apprehended; it is placed near the eye, on the upper surface of the head, and behind the supra-œsophageal ganglion; it is unpaired, and is of a simple character. There is a delicate epithelial band, made up of fine cylindrical cells lying on the transparent cells of the epidermis, and forming a slight projection. In the middle of the band there are two or three rows of cells which are provided with very long delicate cilia. The epithelial bands vary in form in various species; they are supplied by two well-developed nerves, which arise from the posterior surface of the supra œsophageal ganglion, and pass to the olfactory organ along a line parallel to that of the optic nerves.

The *nervous system* of these creatures is of especial interest, inasmuch as the chief ganglia and the nerves from them are imbedded in the epidermis, while some of the smaller cephalic ganglia, with their nerves, belong to the mesoderm; we have, therefore, in the nervous system of the Chætognatha to distinguish an ectodermal and a mesodermal portion. The former consists of two central organs, the supra-œsophageal and the ventral ganglia, together with their nerves; the mesodermal portion is imbedded in the head. The supra-œsophageal or cephalic ganglion is imbedded in the epidermis, and forms a slight outwardly-projecting protuberance; in form it is regularly hexagonal, and it is separated on its lower surface by a supporting lamella from the subjacent musculature. It is made up of a mass of delicate fibres and of small ganglion-cells; from the former there are given off four stronger and six more delicate nerves; two of the former are the anterior motor nerves, and the other two are the commissures by which these are connected with the ventral ganglionic mass. The six more delicate nerves are all sensory. The ventral is larger in size than the cephalic ganglion, and is placed at about the centre of the trunk-segment; owing to its projection outwards, it has by some authors been spoken of as the "ventral saddle." Here again there is a fibrous medullary and a cortical cellular subtsance. In addition to the commissures already noticed, there are given off from it ten to twelve delicate nerves on either side, and two well-developed trunks from its posterior aspect. These various trunks are not distinctly separated from one another, but unite largely so as to form a considerable nerve plexus.

There appear to be considerable difficulties in the way of the examination of the mesodermal portion of the nervous system. Returning to the two *motor* nerves, which are given off from the supra-œsophageal ganglion, we find that they, after passing some way forwards, make a dip into the mesoderm; here they are enlarged into a ganglion, which may be known as the *lateral cephalic ganglion.* This body is semilunar in shape, and consists largely of dotted substance and slightly of superficial cells. Several nerves are given off from it, which pass to the muscles of the head. There are also on either side two very small mesodermal ganglia, which are like those developed on the cephalic nerves. One of these is called the *buccal* ganglion. Certain difficulties still remain to be overcome as to the innervation of the musculature of the trunk; it seems that either the numerous well-developed nerves which are given off from the mesodermal cephalic ganglia supply these parts, or that the superficial tegumentary plexus already noticed sends fibrils to the muscles. The author inclines to the former view, and points out that, if it be correct, the function of the ectodermal nerve-plexus would be to convey stimuli to the ventral ganglion, whence, by the commissures, they would be carried to the supra-œsophageal ganglion, and thence conveyed by the two motor nerves to the musculature. If this view shall be shown to be right, it will clearly follow that, in the Chætognatha, the sensory and motor nervous systems are distinct from one another, and that the former would be ectodermal, while the latter would be, with the musculature, mesodermal in origin.

There are some important points in the characters of the muscular system. As is well known, the muscles of these creatures are transversely striated; it is now further pointed out that the muscular lamellæ are set in such a way that the delicate interspaces between them only open towards the cœlom. Of the questions which we ask ourselves when we examine into the characters of this system one of the most important is that which has reference to the relations of the muscular elements of the Chætognatha to those of other animals. It seems impossible to institute any comparison between them and either the Vertebrata or the Arthropoda, for the muscular fibrils are not arranged in bundles, but in lamellæ; there is, however, a very considerable resemblance to what obtains in the Cœlenterata, and the study of this resemblance seems to lead to the conclusion that in the Chætognatha the muscle-fibrils were, primitively, spread out in a thin lamella, and that, by the growth of this, foldings were formed which led to the leaf-like arrangement which obtains, in some parts, later on; further considerations lead to the important conclusion that myoblasts are to be looked for in the cœlom (body-cavity).

Poor as is the "cephalic cap" in muscles, it has a structure of considerable interest, for it contains the nerve-trunks which connect the ventral with the cephalic ganglion, as well as the eyes and the optic nerves. In *Spadella cephaloptera* there was also to be observed on either side a short tentacular process, which terminates in a knob-like enlargement.

After a short account of the enteric tract and the mesenteries, the author passes to a consideration of the *Generative Organs*. In animals which are sexually mature the hinder portion of the two cavities of the trunk-segment may be seen to be almost completely filled with the two ovaries; these are more or less cylindrical bodies, which are only attached by a thin and short mesentery; they consist of a rather narrow oviduct, and of a true ovary. The contents of the former vary in individuals, and in some cases the author was able to detect in them spermatozoa in active movement. There is some difficulty in understanding how the matured products escape to the exterior; Hertwig is of opinion that it is the hinder portion only of the oviducts which serves for the extrusion of the eggs, while the large cæcal portion functions as a kind of *receptaculum seminis*.

The male organs form, so far as the matrix of the spermatozoa is concerned, a projection into the most anterior portion of the caudal segment; from this there are set free masses of unripe spermatozoa, which may be seen to be executing a regularly circulatory movement. The efferent ducts lie in the hinder portion of the caudal segment, and the short canal has at its anterior end an infundibular ciliated orifice. The spermatozoa are collected into a seminal vesicle, more or less elongated and oval, but varying in form in the various species.

The following table exhibits the system of the group:—

Chætognatha.—Body consisting of three segments, separated by septa, and provided with horizontal fins. The head with prehensile hooks, spines, and a "cap," with two eyes, and an unpaired olfactory organ; cœlom spacious. The enteron has two mesenteries, and opens in front of the anenterous caudal segment. Four longitudinal muscular bands. Nervous system consists of the ventral, the supra-œsophageal, and the lateral cephalic ganglia. Trunk-segment with two ovaries; caudal segment with two testes.

I. *Sagitta.*

Unpaired caudal, two pairs of lateral fins.

(*a*) Species from 3–7 cm. long.

1. *S. hexaptera*; 2. *S. lyra*; 3. *S. magna*; 4. *S. tricuspidata*; 5. *S. bipunctata*; 6. *S. serratodentata*; 7. *S. mariana*; 8. *S. pontica*; 9. *S. diptera*; 10. *S. triptera*.

II. *Spadella.*

Unpaired caudal fin; one pair lateral fins.

1. *S. cephaloptera*; 2. *S. draco*; 3. *S. hamata*.

The fourth chapter of this very valuable essay deals with the development of the Chætognatha, for the study of which *S. bipunctata* and *S. serratodentata* are reported to be very suitable objects. Here we can only very briefly note one or two points. (1) There is formed a typical gastrula. (2) Before this stage is lost, part of the endoblast gives rise to the first elements of the generative organs, and another part to the rudiments of the enteric canal and of the body-cavity. (3) The two large cells in the endoblast of the gastrula give rise to the male and female generative organs. For the further consideration of these and other points our space compels us to refer to the figures and descriptions given in the original.

**Disease produced by Anchylostoma duodenalis.***—The development of this parasite has been followed by Professor Perroncito up to the stage at which it enters the body of man, and is of especial importance with regard to the epidemic caused by it among the workmen at the St. Gothard tunnel. Three parasites occur in the intestine, all producing the same symptoms, and causing the disease known as *Oligœmia perniciosa;* they are *Anchylostoma* (*Dochmius*) *duodenalis*, *Anguillula intestinalis* and *stercoralis*, and may occur in the different subjects either separately or mixed.

*Larval development of Anchylostoma duodenalis* outside the human body.—The eggs are oval, thin shelled, transparent, measuring ·052 by ·032 mm. At twelve to fourteen hours from the commencement of incubation, traces of larvæ are visible in a very few; in one to two days most show larvæ in various stages, and after some days they issue. In eggs kept at between 28° and 33° C. the exit is seen to be made by two or three blows which occur within a minute of each other; the head emerges generally a little to the side of one of the poles; the first effort is the most vigorous, for it springs out, moving the body laterally with great force; the movements continue for a short time, and then a period of quiescence and expansion ensues; the length at birth is ·2 mm. and maximum diameter ·014 mm.; the body is slightly attenuated in front of the pharynx, and ends posteriorly in an awl-like thin tail; the head is trilobate, and a rectangular tube ·014 mm. long represents the mouth; the pharynx has an anterior dilatation, and a little behind this, another, the pharyngeal bulb, carrying chitinous teeth; the whole tube is strongly muscular and leads into an intestine with a zigzag cavity, ending at a slightly prominent anus. The rudiment of the genital apparatus is seen as an oval mass near the middle of the body, on the anal side, between the intestine and the dermal muscular layer. After the first day the larva is ·25 mm. long, and continues to increase at the rate of ·05 mm. per diem, as long as the temperature does not exceed 24° to 25° C.; the maximum length is ·55 mm., the breadth ·02–·024 mm. After eight hours of life, the intestine assumes a straight position. After some days, serpentine movements occur at temperatures even of 14° to 16° C. After the maximum size is attained, the pharynx undergoes modifications, and is finally altogether renewed. Meanwhile,

* 'Atti Accad. Lincei (Transunti),' iv. (1880) p. 179.

the skin excretes a transparent chitinous substance, forming a capsule which encloses the whole animal, allowing of its free movement within. Now the mouth develops the rudiments of its hooks and styles; the intestine becomes less granular and more transparent; between two of the middle segments appear the papillæ which occur on the sides of the perfect worm. The space left in the capsule round the worm gradually diminishes, and, chiefly at the end, calcareous corpuscles are excreted, of round, rectangular, &c., shape, forming a protective crust. The acid of the gastric juice dissolves the coat and leaves the larva free; but death occurs if it does not reach a human body; in the encapsuled state it resists desiccation and the action of indifferent fluids for twenty-four hours, and lives well in clear or muddy water; a single drop of water may contain 100 larvæ.

*Larval Development of Anguillula intestinalis.*— The eggs are oval, with more pointed poles than in *Anchylostoma;* they measure ·05–·06 mm. by ·03–·036 mm. Development progresses well at the temperature 25° to 26° C.; birth takes place in from fourteen to twenty hours; the embryos are more clearly visible, and move more vigorously within the shell, than in *Anchylostoma.* A short quiescent stage ensues on birth, followed by active movements; the length of the larva is ·2–·24 mm., the diameter ·012 mm.; it is slightly attenuated in front and has a very sharp tail. The head is trilobate, the mouth rectangular, with a pharynx and pharyngeal bulb; the intestine is cellular and zigzag; a genital rudiment exists in the same position as in *Anchylostoma.* The larvæ need a liquid medium more, and die if the mass becomes somewhat dry, showing a fatty breaking-down of the tissues, but live in distilled or common water and in 5 to 7 per cent. solutions of common salt or sulphate of soda. In a liquid or semi-liquid medium the larva doubles its length in twenty-four hours, becoming ·016 mm. thick; the head is round, the body cavity is surrounded by the dermo-muscular layer, which secretes a most delicate chitinous capsule for the body.

*Anguillula stercoralis* Bavay, *development of larva* outside human body.—The larvæ are developed in the maternal uterus and are expelled with the fæces at different stages; they are then free and active, measuring ·2–·26 mm. by ·014–·016 mm.; the anterior end of the body is larger, the mouth shorter, the pharynx shorter and broader, the intestine longer and wider than in the same stage of *Anchylostoma.* The genital rudiment is very characteristic, being shuttle-shaped and ·025 mm. by ·003 mm. in size. Encapsulation generally takes place in a day. Experiments with different temperatures proved that the larvæ always exhibited movements within five seconds at a temperature of 50° C.

Facts show that these worms were alone sufficient to cause the disease of anæmia observed at the St. Gothard tunnel; the disease probably resulted from the unfavourable conditions under which so many poor workmen were engaged together.

*Anguillula intestinalis* should be removed from that genus, and is better named *Strongylus papillosus*, the reasons for which change of name are reserved.

**Organization and Development of the Gordii.*** — M. A. Villot insists upon the fact, that the first larval form of the *Gordius* differs greatly from that of the Nematoid worms. In these latter, even including the aberrant genera (*Mermis* and *Sphærularia*) the embryo and the larva are represented by the types of the Anguillulæ (*Rhabditis*). Now it would need a great effort of imagination to refer the larva of *Gordius* to this type. The order Gordiacei, as established by Von Siebold, cannot, therefore, be retained by zoologists, who nowadays attach the greatest importance to the characters furnished by embryogeny and morphogeny.

The second larval form differs from the first as much as the latter differs from the sexual form. It is characterized essentially by the loss of the styles, the shedding of the hooklets, and the disappearance of the annulations.

Each of the two larval periods includes two very distinct phases, that of parasitism and that of aquatic existence; but these two phases do not in each case occur in the same order. In its first larval form the young *Gordius* passes from aquatic life to the state of a parasite; in its second larval form it quits its post to return to the water. The two phases of parasitism, although immediately succeeding one another, differ essentially. So long as the first phase lasts, the young worm, enclosed in its cyst, remains motionless, and does not appear to take any nourishment or to grow at all. During the second, on the contrary, it is free, lives at the expense of its host, and becomes very rapidly developed.

It has been supposed hitherto that the passage from the first larval form to the second is connected with a migration, a change of host. The observers who saw larvæ of *Gordius* encyst themselves in larvæ of Ephemeridæ supposed that the Dyticidæ swallowed these encysted larvæ with their prey, and that the young *Gordii* developed themselves in the visceral cavity of their new host. For this hypothesis, which is still classical, the author substituted another which appeared of more general application. He said that the *Gordii* parasitic upon fishes proceed from larvæ previously encysted in various species of Tipulidæ, the larvæ of which likewise lived in the water; and he founded his argument upon the consideration that fishes are in general very fond of those insects. Both hypotheses are contradicted by the well-ascertained fact that the two larval forms of the *Gordii* live indifferently in the various aquatic hosts indicated. He therefore now regards it as very probable that the two phases of the parasitism of the *Gordii* are accomplished in one and the same host.

Observation also proves that the larvæ of the *Gordii* do not select their host. They encyst themselves and become developed in the most different animals (Batrachians, fishes, Crustaceans, Arachnids, insects, and molluscs). It is therefore by no means the case, whatever may have been said, that the larvæ of the *Gordii* are parasites *peculiar to insects*. As regards fishes, these are perhaps the animals which harbour these larvæ most frequently and in the greatest number.

* 'Comptes Rendus,' xci. (1880) p. 1569. See 'Ann. and Mag. Nat. Hist.,' vi. (1880) p. 169.

It is none the less evident that the *normal hosts* of the *Gordii* are all animals exclusively or temporarily aquatic. Water is, in fact, the normal medium of the *Gordii*. It is in the water that they become adult, and that they reproduce; it is in the water that their larvæ live at first on their escape from the egg; and it is also in the water that their migration must be effected.

The parasitism of the larvæ of the *Gordii* in terrestrial animals has an essentially abnormal and exceptional character; and in order to explain it we must have recourse to very peculiar conditions. In plains these are realized by the periodical inundations and systematic irrigations,—in mountainous and hilly countries the escaping torrents carry away everything in their course, the insects perish, and the worms which they contain are set at liberty.

The frequency of the larvæ of *Gordii* in insects, which is cited as an objection to the author's views, is more apparent than real. It must be remembered that the insects are represented by a great number of species, and are sought after by most naturalists.

**Excretory System of the Trematoda and Cestoda.***—M. Fraipont, in a preliminary notice as to the results at which he has arrived, says that

(1) The excretory apparatus arise from small, and not numerous, infundibula, which communicate with the spaces between the organs by an orifice placed in their lateral wall. The greater part of every infundibulum is formed by a single cell armed with a vibratile flagellum.

(2) In the intervening spaces he finds a system of very delicate canalicula, which are arranged in a radial fashion.

(3) The infundibula are arranged almost symmetrically on either side of the middle line, and each gives rise to a small canal, several of which converge, anastomose, and then open into a system of large vessels, placed at six definite points in the body, and symmetrically disposed two by two. There may, consequently, be said to be three pairs of segmental organs, and it is of interest to remember that in the larval Hirudinea there are three pairs of segmental organs in the posterior region.

(4) The system of large canals form two lateral trunks, which rapidly bifurcate; of the branches thus formed, one passes towards the middle line to anastomose with its fellow of the opposite side. The other passes along the whole of the lateral edge of the body, and after giving off diverticula which increase in complexity with the age of the individual, terminate blindly. The trunks themselves open into a terminal reservoir, which is filled with highly refractive corpuscles, and opens to the exterior in the middle line and at the hinder end of the body.

The preceding being an account of what is found in such Trematoda as *Polystomum integerrimum*, *Octobothrium lanceolatum*, and *Diplozoon paradoxum*, we have next to inquire what obtains in the Cestoda. In *Caryophyllæus mutabilis* there is the following arrangement:—

* 'Bull. Acad. Roy. Belgique,' xlix. (1880) p. 397.

(1) There are small ciliated infundibula, *identical* with those just described.

(2) The canaliculus from each infundibulum has a more or less tortuous direction. They are arranged in groups, and anastomose with one another.

(3) They give rise to a superficial plexus, whence two large trunks pass from behind forwards, on either side; and these four are connected anteriorly with ten large longitudinal trunks.

(4) These last anastomose largely in the head, and during their course communicate with one another by transverse branches; they open by ten orifices into a reservoir at the hinder end of the body.

The ciliated infundibula have also been detected in the cysticerci of *Tænia serrata*, in the adult *T. serrata*, and in *T. cucumerina*.

The author refrains for the present from entering into any general speculations, and contents himself with pointing out the bearings which the facts he details have on the affinity between the Platyhelminthes, on the one hand, and the Rhyncocœla and Hirudinea on the other. These worms may, he thinks, be divided into the Cœlomati and the Acœlomati; for the latter (the Trematoda and Cestoda) have the cœlom, in which the hæmolymph circulates, in a rudimentary condition.

**Development of the Liver Fluke.***—M. Baillet shows that segmentation may begin, and even be completed, while the egg is unlaid, or the process may take place in the bile-ducts or gall-bladder of the host. Further, the withdrawal of the eggs from the body of the latter does not kill them, as is the case with the Nematode, *Sclerostomum*. Media seem, in fact, to be of little importance in this matter, for presence or absence of light, immersion in common water, in water containing organic matter in solution, in damp earth, alike seem to influence neither the quickness nor perfection of the development.

**Anatomy of the Nemertinea.**†—Herr Dewoletzky has come to the following conclusions, as he states in a preliminary account:—

(1) The tegumentary epithelium contains other than the two forms of cells already recognized; there are filamentous supporting cells, gland cells, both mucous and granular, as well as the terminal cells of nerves, and cells which secrete pigments, or concretions of definite form.

(2) The œsophageal epithelium is devoid of mucous cells; the supporting cells are shorter and more massive; while the granular cells are not deeply inlaid, and only communicate with the exterior by fine efferent ducts.

(3) In the sensory epithelium there appear to be no glands at all; while

(4) In the epithelium which lines the canal of the lateral organ the glands are confined to two points.

* 'Mém. Acad. Sci. Inscrip. et Belles-Lettres,' Toulouse, 1879. See 'Rev. Sci. Nat.,' ii. (1880) p. 114.

† 'Zool. Anzeig.,' iii. (1880) p. 375.

After reminding the reader that the so-called lateral organ has, by the latest researches, been seen to be composed of a number of ganglionic cells and of a fibrous cord, together with a ganglion invested in a membrane of connective tissue, and that there lies in it a blindly ending ciliated canal, the author states that, as to this last, it forms in the first third of its course a wide cylindrical vestibule, which suddenly narrows. At the two points where the lumen of the canal is constricted, there are to be found the orifices of a number of long, fine efferent ducts, which pass off from the unicellular glands, and are massed together on the surface of the ganglion. The cilia which line the canal work towards the blind end. The structure of the narrower portion of the canal is somewhat remarkable; there is a layer of longish, compressed, rod-shaped corpuscles, set almost completely at right angles to the lumen; these rods appear to be the bases of the projecting cilia. The special investment of the canal would appear to be a specific sensory epithelium, modified from the ordinary tegumentary layer, while the gland cells have been pushed inwards (downwards) by the ganglionic masses of the lateral organ, and further, have become localized to two distinct points, where, clearly enough, they take on the function of defending the sensory epithelium.

As to the proper sensory organ, the function of which is not known, the author suggests that, as in so many other aquatic and marine forms, we have to do with a rudimentary organ which has some function in relation to the character of the water. He is reminded by what he has seen in the Nemertinea of the organ of Lacaze-Duthiers in the fresh-water Pulmonata, and he is supported in his view by the fact that just as one organ is absent in the terrestrial Pulmonata, so is the other in the terrestrial Nemertinea.

The enteric epithelium consists of glandular and of elongated absorptive cells; the latter contain a number of highly refractive spheres, which appear to be of an albuminous nature, and are apparently drops of digesting food. Between the circular muscular layer and the epithelium there is, in all the Nemertinea, a more or less well-developed layer of connective tissue, which is distinguished by the author as the subtegumentary connective tissue; it has been described as a "basilar membrane," but it is provided with distinct corpuscles, and is not structureless. In all Anopla the nervous system seems to lie between this tissue and the circular musculature; in the more differentiated Enopla it lies beneath the circular muscles.

The excretory system of *Tetrastemma* is described as possessing two long primary trunks, which, anteriorly, pass into an elaborate coil of loops lying behind the cerebral ganglia; among others, there pass off from this coil an efferent duct, which opens to the exterior, just behind the brain.

Dr. Hubrecht publishes a note * stating that he finds only in the Hoplonemertini a peripheral nervous system, where it has the form of regular dichotomously branching trunks arising from the lateral nerve-trunks; in *Carinella*, which Dr. Hubrecht looks upon as being the most primitively organized genus of the Palæonemertini, there is,

* 'Zool. Anzeig.,' iii. (1880) p. 406.

externally to the supporting lamella, a layer of nerve-fibres which forms a plexiform envelopment for the whole body. In its histological characters, this layer appears to be similar to the ectodermal nerve-fibre-layer, found by the Hertwigs in the Actiniæ.

In all the Schizonemertini, as well as in *Polia* and *Valencinia*, the layer has the same histological structure as in *Carinella*, but it differs in position, for it lies between the circular and the outer longitudinal muscular layer. This leads to the view that it is possible that this layer is a greatly developed ectodermal musculature. In the Hoplonemertini this special nervous layer seems to have disappeared.

**Intestinal Worms in the Horse.***—H. Krabbe has published an interesting account of the occurrence of intestinal worms in the horse.

As the horse is spread over the greater part of the inhabited world, and under conditions of life very varied, it might be supposed that, like man and the dog, it would not be equally affected with these parasites, nor with the same species. To determine with some degree of accuracy the Entozoa which in Denmark are found in the intestinal canal of the horse, M. Krabbe examined, during the last four years, the bodies of 100 horses which were brought for anatomical purposes to the Veterinary College of Copenhagen, between the months of September and April in each session.

In these horses he found *Tænia perfoliata*, 28 times; *T. mamillana*, 8 times; *Ascaris megalocephala*, 16 times; *Strongylus armatus*, 86 times; *S. tetracanthus*, 78 times (in 67 horses out of 86); and *Oxyuris curvula*, twice. Of *T. perfoliata* the number found was mostly less that 25; sometimes it was over, and twice between 100 and 200 were found, while once no less than 400 were met with. In general they were lodged in the cæcum. *T. mamillana* of Mehlis, a species overlooked by Dujardin and most French writers on the subject, was described and figured by Gurlt in 1831; generally less than 25, but sometimes up to 72, were met with, mostly in the anterior part of the small intestine (*T. plicata* R. was never met with). The *Ascaris* never occurred in larger numbers than 11. *S. armatus* was never met with in the small intestine; in the cæcum it was common; much less so in the first portion of the colon, where very fine specimens of a dark bluish red colour were found; generally the number met with was below 25, but once nearly 200 were found. Of 1409 samples, 1029 were females and 380 males. *S. tetracanthus* was found in the cæcum and throughout the colon, and *Oxyuris curvula* also in the colon.

The literature of this subject would appear to be very scanty, and the author hopes that the attention of veterinary surgeons in other parts of the world may be attracted to it. Ample opportunities of following it up exist in British India, America, and the Cape of Good Hope district.

**Parasites of Helminthes.**†—M. Moniez directs attention to a somewhat curious fact. The *Echinorhynchi* have generally been

* 'Overs. K. Dansk. Vidensk. Selsk. Forh.,' 1880, p. 33, and 'French Résumé,' p. 9. See 'Nature,' xxii. (1880) p. 277.

† 'Bull. Sci. Dép. Nord,' iii. (1880) p. 301.

regarded as not being infested by psorosperms, but he has been able to detect them in examples of *E. proteus*. They were figured by O. F. Müller in his 'Zoologia danica,' but were taken by him for the first two stages in the development of the young *Echinorhynchus*.

In the same note he states that in *Tænia expansa* he has seen a large number of corpuscles very closely allied to the organism which produces *pébrine*. Once, also, he detected them in *T. denticulata*, but the specimen in question was associated with an example of the former species, which was full of these organisms.

**Bodies found on Meat.***—On the refuse of certain meat from the abattoir at Nancy, M. Poincaré has found bodies, which were in no way encysted, among the muscular fibres, to which, however, they were so intimately attached as to seem at first sight as if they occupied a zone in the cavity of the sarcolemma; they were found to be independent of it, and, indeed, no examination is, in most cases, necessary to demonstrate this, as the bodies become isolated spontaneously. The body is cylindrical, with two conical extremities, with a distinct cuticle, and presenting a number of lines which circumscribe the large cells; within, there is a granular mass, but no distinct signs of internal organization were to be made out. The bodies were, on the average, 0·05 mm. wide, and 0·28 mm. long; the size varied a good deal. Notwithstanding the absence of any distinct organization, they appear to be independent organisms, and it is suggested that they are examples of some one phase in the metamorphoses of tænioid forms. For the moment, the author contents himself with directing attention to their presence.

**Floscularia ornata.**†—Mr. T. B. Rosseter, when watching this floscule, saw enter its mouth a large brown mass which was too large to pass from the funnel into the vestibule; the latter began to swell, the contractile rim gradually opened, the whole of the setæ on the lobes were turned inwards and thrust down the trochal disk on to the brown jelly-like mass, piercing it like so many needles, thrusting it from the vestibule through the contractile rim into the mouth, which instantly became distended, and the prey passed down into the stomach; the lobes were drawn upwards, and again resumed their feather-like appearance.

**Prothelminthus, a new low Vermian Form.**‡—The species described by M. Jourdain under this new generic name was, like *Intoshia leptoplanæ* of Giard, found on the Planarian *Leptoplana tremellaris*; it was found, however, on the surface of the body, instead of in the gastric cæca, but is, notwithstanding, probably the same species. It lives alone in a cavity in the integuments of the worm, similarly to *Intoshia linei*, as discovered by Giard.

There are two kinds of individuals. Both have a vermiform shape, are rounded at both ends, and divided into more or less distinct segments, and are entirely covered by cilia, of which the terminal

* 'Comptes Rendus,' xci. (1880) p. 177.
† 'Sci.-Gossip,' 1880, p. 182.
‡ 'Rev. Sci. Nat.,' ii. (1880) p. 68 (1 plate).

ones are the larger and more rigid. A digestive cavity appears to extend throughout the body; at one end, surrounded by hairs, is a dilatable opening, which is lined by crystalline rods, as in *Chilodon*. No other organs have been found. The only movements detected were those of rotation round the long axis of the body, caused only by the external cilia, and of a bending and displacement of segments, probably due to contractile mesodermic tissue.

Of the two kinds noticed, the larger are the *females*, which vary from ·13–·15 mm. in length, with a breadth of ·03 mm.; they are dark green, and the surface appears to be finely punctate. There are nine or ten quite distinct segments, followed by a terminal part in which the segments are very indistinctly marked, but which perhaps represents five more, thus agreeing in the main with the species figured with some hesitation as *Intoshia leptoplanæ* by Keferstein. The smaller individuals are less numerous, and measure ·1 by ·02 mm. They are hardly at all pigmented except at the posterior extremity; they are probably the *males*, but no male elements have been found in them. The segments appear to be about twelve or thirteen. Some individuals show a strong median constriction, and some are found in a kind of cyst. If the presence of a digestive canal with two openings should be established, the species will have to be excluded from the *Orthonectida*. The name given to it (subject to its not being proved to be identical with *I. leptoplanæ*) is *P. Hessei*.

**New Synthetic Type.***—At a meeting of the Zoological Section of the Russian Association of Naturalists, A. Kowalevsky gave an account of *Cœloplana Metschnikowii*, a new form which lives on *Zostera* in the Red Sea, and which constitutes a type intermediate between the Cœlenterates and the Planarian worms.

In its outer form it resembles a Planarian; it is grey above, white below, and about three lines in length by two in breadth. Like all Planarians, it crawls on the whole ventral surface, in the middle of which is a slit-like opening communicating with a four-lobed stomach which resembles most nearly the "funnel" of the Ctenophora; from it originate a large number of canals which radiate to the periphery of the animal and open into a ring canal which bears many cæcal appendages. On the dorsal surface, almost directly over the mouth, is a vesicle containing a number of vibratile otoliths. On either side of this otocyst is a sheath from which can be protruded a long retractile tentacle. Each tentacle is branched and corresponds in shape to those of *Cydippe* and *Eschscholtzia*, only they have no central canal, but are composed of muscles. The nervous system and genitalia were not observed. The whole surface of the body is covered with vibratile cilia.

### Echinodermata.

**Development of the Echinodermata.**†—Dr. Goethe states that, when lately looking through some preparations of *Bipinnaria* made by Herr Meyer at Naples, he observed a mode of development of the

* 'Zool. Anzeig.,' iii. (1880) p. 140; see 'Am. Natural.,' xiv. (1880) p. 531.
† Ibid., iii. (1880) p. 324.

vaso-peritoneal system which does not seem to have been hitherto noticed. Between an apical cæcal sac and the œsophagus he saw on either side an outgrowth, which was partly separated by a constriction from the rest of the enteron. In other preparations he saw these processes separated from the enteron, with the stone-canal immediately between them. The double sac thus formed became, later on, very unequally developed on the two sides. This observation is interesting as allying the Asterida on the one hand with the Echinoidea and Holothuroida, and on the other with the Crinoida. In reference to this last group the author takes the opportunity of stating that he was wrong in following Johannes Müller in supposing that the first orifice which appears between the first and second ciliated band is completely obliterated, and he has now been convinced by the demonstrations of Metschnikoff that the first band does not become complete until the orifice comes to lie within its area.

**Echinoderms of the Norwegian North Sea Expedition.***—Messrs. Danielssen and Koren continue their account of the Holothurians belonging to Dr. Theel's group, the Elpididæ, by very fully describing a form assigned to a new genus (the third now known), and to be called *Kolga hyalina*. Their specimens do not exceed 50 mm. in length. It is very distinctly bilateral, the back being strongly convex; its anterior edge, above the tentacles, forms a kind of collar, with six conical-pointed papillæ. The mouth looks in the same direction as the ventral side of the body. Of the parts of the skin, certain globular nucleated glands with thick walls lying between the cuticle and corium are to be specially noticed; they probably are mucous in character. Of the three forms of spicula, one which is narrow, sinuous, and doubly pointed, but smaller than in *Irpa*, is found ventrally; the large forms are also curved, and more or less spinous; the former measure ·024 by ·002 mm.; the latter, ·357 by ·008 mm.; the third kind, belonging to the oral disk, is either linear, angulated, and spined, or rosette-shaped, or reticular. Of the internal skeleton the calcareous rings are rather rudimentary: the five pieces which compose them are very thin, and of almost uniform thickness throughout. The oral disk carries ten tentacles; the anus is dorsal; the sexes are separate; no anal appendages exist. Found off north of Norway, at 71° 59′ N. lat., 1200 fathoms.

A second new generic type is described as *Acanthotrochus mirabilis*. It is cylindrical, apodal, posteriorly rounded off; the sexes are distinct; no anal respiratory appendages; skin provided with two kinds of calcareous spicules, the one with alate rays and with long inwardly directed teeth on the circumference, the other more than twice as large, and with long teeth projecting outwards from the periphery; there are twelve non-retractile tentacles; the locality is 73° 47′ N. lat., 14° 21′ E. long.; the depth, 767 fathoms.

*Ankyroderma* is a third new genus, represented by two species, *A. Jeffreysii* and *affine*, found at depths less than 500 fathoms; the chief characters show the body to be cylindrical, the anterior end

* 'Nyt Mag. Naturvid.,' xxv. (1879) p. 83, 3 (6) plates.

truncate, the oral disk provided with fifteen oblong depressions, containing the same number of papilliform tentacles, and alternating with fifteen tubular processes also on the disk; the posterior end is produced tail-wise, the cloacal opening surrounded by five papillæ; the skin carries perforated papillæ provided with peculiar calcareous bodies, consisting of five to six stellately arranged spoon-like rods from the centre of which project the anchors; feet absent; two anal appendages. *A. Jeffreysii* was found chiefly in the most northern fiords of Finmark; the other species at 72° 27′ N. lat., 20° 51′ E. long.

The other species recorded by them are *Myriotrochus Rinkii* Steenstrup, *M. brevis* Huxley, *M. Rinkii* Theel (which differs from Steenstrup's species in having more tentacular cirrhi, &c.), *Oligotrochus vitreus* Sars, *Trochostoma boreale* Sars, *T. arcticum* Marenzeller.

Synthetic Type of Ophiurid.* — Professor P. Martin Duncan describes a very remarkable Ophiuran which forms part of a collection obtained by Dr. Wallich, during his voyage in H.M.S. 'Bulldog,' in the year 1860, off the coast of East Greenland. The Ophiuran was presented by him to this Society.

The Ophiuran—*Polypholis echinata*—$\frac{3}{10}$ inch long, and the body $\frac{1}{12}$ inch in diameter, came up with the sounding apparatus from off the sea-floor at a depth of 228 fathoms, about 50 miles north and east of Cape Valloe, East Greenland, and about 200 miles from Cape Farewell, date July 19, 1860, lat. 60° 42′ N., long. 41° 42′ W. The "cup" came up full of fragments of granite and felspar, to which were adherent small corallines. Some of them were very delicate, and their perfect condition indicated an undisturbed state of the bottom water where they occurred. There was a sudden decrease of depth close to the spot, and the water shallowed 578 fathoms in three miles.

Although a young form, this specimen presents the normal structures of an Ophiuran, and it is in no way deformed or abortive. The extreme simplicity of the oral apparatus is in itself remarkable; there are true teeth, but the spines on the side mouth-shields are the only mouth papillæ, and they are so called because it is the fashion, erroneously, so to call all growths from the sides of the jaw-angles and side mouth-shields. The use of the small spines on the side mouth-shields is that of tentacle-scales, and they can have nothing to do with alimentation. This remark holds good in the majority of instances where the spine arises from the jaw, close to the side mouth-shield and tentacle-opening.

There are no tooth-papillæ, and the knob-like projection within the jaw plate beneath the true teeth, so like that of some Amphiurans, is not seen on all the angles. It comes doubtfully, however, within the description of mouth-papillæ, and appears to be a true tooth. The regularity of the pentagon surrounding the oral apparatus is very striking, and so is the extreme separation of the jaw-angles, much of which, however, may be due to *post-mortem* contraction. All the plates on the upper surface of the disk have separate, broad based,

* 'Journn. Linn. Soc.' (Zool.), xv. (1880) p. 73.

two or three-thorned, short spinules on their edges, and rarely elsewhere, but the spinulation is not distinct between them. The radial shields have the greatest number of spinules on them. All the spines on the side arm-plates project at right angles to the arm, and the hooks are glassy at their top. The combination of Amphiuran characters and those of *Ophiothrix* is thus remarkable.

**Hæmoglobin in the Aquiferous System of an Echinoderm.***—M. Fœttinger reports the important discovery of hæmoglobin in an Ophiurid—*Ophiactis virens*. In the elements discovered by Simroth in the water-vascular system of this species, the writer was, with living specimens, enabled to detect a bright red colouring matter. Spectral analysis revealed the presence of the two bands characteristic of the oxyhæmoglobin of the Vertebrata. The cells in which it is contained were seen to be nucleated, but in addition to these there were also found a number of free nuclei and small corpuscles, which were also charged with hæmoglobin. The author would seem to agree with Simroth in recognizing the presence of a vascular system, independent of the water-vascular, and charged with a nutrient function; this contains a colourless liquid. On the other hand, the system with the red corpuscles has a respiratory function.

**Buccal Skeleton of the Asterida.†**—In this note M. Viguier, while replying to some criticisms of Dr. Hubert Ludwig,‡ reaffirms the existence of two parts in the "support of the tooth." The fact that there is no trace of any fusion is relied upon greatly by Ludwig, but Viguier points out that in reality the difference between them lies in the fact that what has been taken for the first ambulacral piece is composed of two, which always become separated under the action of potash. This is a statement of fact, which it will be possible to verify or to disprove.

**New Cretaceous Comatulæ.§**—Mr. P. Herbert Carpenter describes five new species of *Antedon* from British cretaceous deposits, two of them in the possession of the Rev. P. B. Brodie, the rest in the collection of the British Museum. The species are:—*Antedon perforata* and *A. Lundgreni*, from the upper chalk, Margate; *A. striata*, from the upper chalk, Dover; *A. laticirra*, from the chalk of Wylye, Wiltshire; and *A. incurva*, from the upper greensand, Blackdown. The author further gives a tabular key to the known English cretaceous species of *Antedon*, and in conclusion refers to certain peculiarities in the structure of these fossils, apparently subservient to the circulation of water in their interior.

### Cœlenterata.

**Structure and Origin of Coral Reefs and Islands.‖**—Darwin's theory may be said to rest on two facts—the one physiological, and

* 'Bull. Acad. Roy. Belgique,' xlix. (1880) p. 402.
† 'Arch. Zool. exp. et gén.,' viii. (1880) p. 1.
‡ See this Journal, *ante*, p. 446.
§ 'Quart. Journ. Geol. Soc.,' xxxvi. (1880).
‖ See 'Nature,' xxi. (1880) p. 351. Abstract of paper read at the Royal Society of Edinburgh.

the other physical—the former, that those species of corals whose skeletons chiefly make up reefs cannot live in depths greater than from 20 to 30 fathoms; the latter, that the surface of the earth is continually undergoing slow elevation or subsidence.

The corals commence by growing up from the shallow waters surrounding an island, and form a fringing reef which is closely attached to the shore. The island slowly sinks, but the corals continually grow upwards, and keep the upper surface of the reef at a level with the waves of the ocean. When this has gone on for some time a wide navigable water channel is formed between the reef and the shores of the island, and we have a barrier reef. These processes have but to be continued some stages further, when the island will disappear beneath the ocean, and be replaced by an atoll with its lagoon where the island once stood.

According to this simple and beautiful theory, the fringing reef becomes a barrier reef, and the barrier reef an atoll by a continuous process of development.

Professor Semper,* during his examination of the coral reefs in the Pelew group experienced great difficulties in applying Darwin's theory. Similar difficulties presented themselves to the author of this paper, Mr. John Murray, of the 'Challenger' Expedition, in those coral regions visited during the cruise of the 'Challenger.' The object of the present paper is to show, *first*, that while it must be granted as generally true that reef-forming species of coral do not live at a depth greater than 30 or 40 fathoms, yet that there are other agencies at work in the tropical oceanic regions by which submarine elevations can be built up from very great depths so as to form a foundation for coral reefs; *second*, that while it must be granted that the surface of the earth has undergone many oscillations in recent geological times, yet that all the chief features of coral reefs and islands can be accounted for without calling in the aid of great and general subsidences.

The most recent charts of all coral reef regions have been examined, and it is found possible to explain all the phenomena by the principles advanced in the paper, while on the subsidence theory, it is most difficult to explain the appearance and structures met with in many groups; for instance, in the Fiji Islands, where fringing reefs, barrier reefs, and atolls all occur in close proximity, and where all the other evidence seems to point to elevation, or at least a long period of rest. In instances like the Gambier group the reefs situated on the seaward side of the outer islands would grow more vigorously than those towards the interior; they would extend in the direction of the shallower water, and ultimately would form a continuous barrier around the whole group. The distinguishing feature of the views now advanced is that they do away with the great and general subsidences required by Darwin's theory, and are in harmony with Dana's views of the great antiquity and permanence of the great ocean basin, which all recent deep-sea researches appear to support.

* 'Zeitschr. wiss. Zool.,' xiii. p. 563.

The results of the paper may be summarized thus:—

(1) Foundations have been prepared for barrier reefs and atolls by the disintegration of volcanic islands, and by the building up of submarine volcanoes by the deposition on their summits of organic and other sediments.

(2) The chief food of the corals consists of the abundant pelagic life of the tropical regions, and the extensive solvent action of sea-water is shown by the removal of the carbonate of lime shells of these surface organisms from all the greater depths of the ocean.

(3) When coral plantations build up from submarine banks, they assume an atoll form, owing to the more abundant supply of food to the outer margins, and the removal of dead coral rock from the interior portions by currents, and by the action of the carbonic acid dissolved in sea-water.

(4) Barrier reefs have built out from the shore on a foundation of volcanic débris, or on a talus of coral blocks, coral sediment, and pelagic shells, and the lagoon channel is formed in the same way as a lagoon.

(5) It is not necessary to call in subsidence to explain any of the characteristic features of barrier reefs or atolls—all these features would exist alike in areas of slow elevation, of rest, or of slow subsidence.

(6) All the causes here appealed to for an explanation of the structure of coral reefs are proximate, relatively well known, and continuous in their action.

**New Mode of Reproduction among the Hydroida.***—Dr. Goette describes the structure and history of a new species of Hydroid-polyp, which he discovered on a Campanularian during his recent visit to Naples; he calls it *Hydrella ovipara*, and describes it as having a creeping stolon which bears here and there simple branches, which are scarcely 1 mm. in length, and terminate in a hydranth. A skeletal tube, irregularly annulated at its base, invests the body, but does not form a proper hydrotheca. Remarkable stages were observed in the characters of the stalk, which was in some cases completely atrophied at its middle, so as to be reduced to a thin filament, and to be composed only of the ectoderm. It would appear that *H. ovipara*, like some other Hydroids (e. g. *Eudendrium*), undergoes a degeneration of some of its polyps at the period of sexual maturity; the ova are developed from endodermal cells, and within the stalk; here the eggs undergo their further development, instead of being conveyed into a gonophore, while the remaining part of the neighbouring endoderm undergoes atrophy. These observations are sufficient to demonstrate that there is no polymorphism and no alternation of generation in this species. With this we should note the fact that in many species of Lafoeida no alternation has yet been detected, and it is possible that there is none to be observed.

Forms a little more distant, e. g. *Cordylophora*, exhibit an incomplete development of this alternation of generation, ova being deve-

* 'Zool. Anzeig.,' iii. (1880) p. 352.

loped in some of the sterile polyps; in all others the alternation is complete. Though the phenomenon is of course associated with polymorphism, it is not to be regarded as simply due to it; the limitation of sexual reproduction to some of the similar individuals of a stock, and the limitation of the gonophore to the mature polyps, is to be regarded as a process anterior to the truly secondary phenomena of polymorphism.

Origin of the Generative Cells in the Hydroida.*—Dr. Weissman, in continuation of his researches† has discovered that the male generative cells may arise in the cœnosarc. Basing his result on what he was able to observe in *Plumularia echinulata*, we find him saying that in the male, as well as in the female, gonangia were developed at points on the stalk thus; a small group of ovarian or seminal cells are, first of all, found in the endoderm, without any indications whatever of any change in the perisarc or ectoderm. Around this primitive reproductive organ there become developed a special cap of cells of the ectoderm; these cells become very remarkably and specially modified, are set at right angles to the supporting membrane, and contain in the outer portion a fluid; this, which is probably a secretion, causes an outswelling of the perisarc. In this last a cleft gradually appears, which grows deeper and deeper; through this grow out the ectodermal and endodermal cells, covered by the perisarc, and a gonangium is thus developed.

The further generalization that in *Cordylophora* the ovarian cells arise in the trunk and not in the stalks of the hydranths, is supported by the observation that the groups of ovarian cells are to be found in quite young hydranth-buds, before any tentacles are developed, and while the stalk is still quite short. Of course this mode of forming generative cells is not found in all Hydroids (e. g. *Tubularia*); so that with regard to the mode of origin of their generative cells, Hydroida may be ranged in two series; in one the generative cells arise in the cœnosarc, and the so-called generative individuals are of secondary origin; in the other the generative individuals are primary, and it is only in them that the generative cells are developed; the former are *Cœnogenous*, the latter *Blastogenous* Hydroids. Further speculation as to the phylogenetic bearing of these observations is deferred for the present.

## Porifera.

Occurrence of Foreign Spicules in Sponges.‡—In two cases, Mr. S. O. Ridley has shown this interesting and, to the working zoologist, important phenomenon to have occurred. A species of *Ciocalypta*, characterized by a fibre which is almost wholly composed of long, singly pointed ("acuate") spicules, with a simple rounded head and sharp point, and by the almost absolute bareness of the outer or dermal membrane in the natural condition, was found to contain in the latter, in addition to the terminal spicules of the fibre proper, certain long smooth spicules of about the same proportions, but with a slight oval

* 'Zool. Anzeig.,' iii. (1880) p. 367. † Ibid., p. 226.
‡ 'Journ. Linn. Soc.' (Zool.), xv. (1880) p. 149.

head at the rounded end; these were apparently part and parcel of the sponge, both on account of their perfect condition and their frequent occurrence in bundles, as if in nature. They proved, however, to be derived from a species of *Esperia*, common in the same waters, and possessed of a peculiarly fragile spicular dermis, the size of whose spicules agreed closely with those now found, and which had no doubt parted with them with great readiness by the fracture of its brittle covering.

The second case was that of a species of *Alebion*, with spined skeleton spicules; besides other forms, among the bundles of short skeleton spicules and in the superficial tissues, there occurred, singly and in fasciculi, precisely the same spicula as those which intruded into the *Ciocalypta*, and to almost as great an extent. In the former case the close resemblance of the intruding to the skeleton spicules offered great temptations for them to be assigned to the proper spicule complement, whereas they were undoubtedly derived from the same species of *Esperia*.

In conclusion, the writer points out the need of careful observation of the position and circumstances in which all spicules occur in any sponges examined, as cases like the present are apt to occur in which neither the broken or partially absorbed condition of these foreign bodies, nor their markedly alien type, are present to point to their real nature and prevent their ranking with the regular structures, and perhaps assigning the sponge to a wrong genus.

## Protozoa.

**Tentaculate, Suctorial, and Flagellate Infusoria.***—Prof. Ch. Robin first deals with *Ophryodendron abietinum* Claparède, Plate XVIII. (Figs. 1, 2).† This species adheres to Sertularians, chiefly *Sertularia pumila*; it may be globular, ovoid, or discoid, is generally bilobate, and has a long retractile tentacle (*d*), terminated by a bunch of mobile cirrhi (*e*); its diameter is from ·06–·13 mm. It is strongly attached by a short pedicle (*a*), which is often concealed by the application of the whole lower surface of the body to the point of fixation. When removed, the body may become globular. A groove (*b*) divides the

* 'Journ. Anat. Physiol.' (Robin) xv. (1879) pp. 529–83, plates xxxix. to xliii.

† Fig. 1.—*Ophryodendron abietinum*, separated by pressure from the Sertularia to which it adhered, to show its point of adhesion, *a*, and the general form of the body.

*b*, partially effaced furrow which divides the body; *c*, point where the tentacle springs from the body; *d*, transverse folds of the retracted tentacle; *e*, terminal bunch formed of the cirrhi of the extremity of the tentacle.

Fig. 2.—*Ophryodendron* after compression, the furrow having thereby disappeared.

*a*, *d*, *e*, as Fig. 1; *c*, *h*, *i*, a lobed gemmiform body; *l*, worm or larva of parasitic worm; *j*, *k*, the hook by which it adheres.

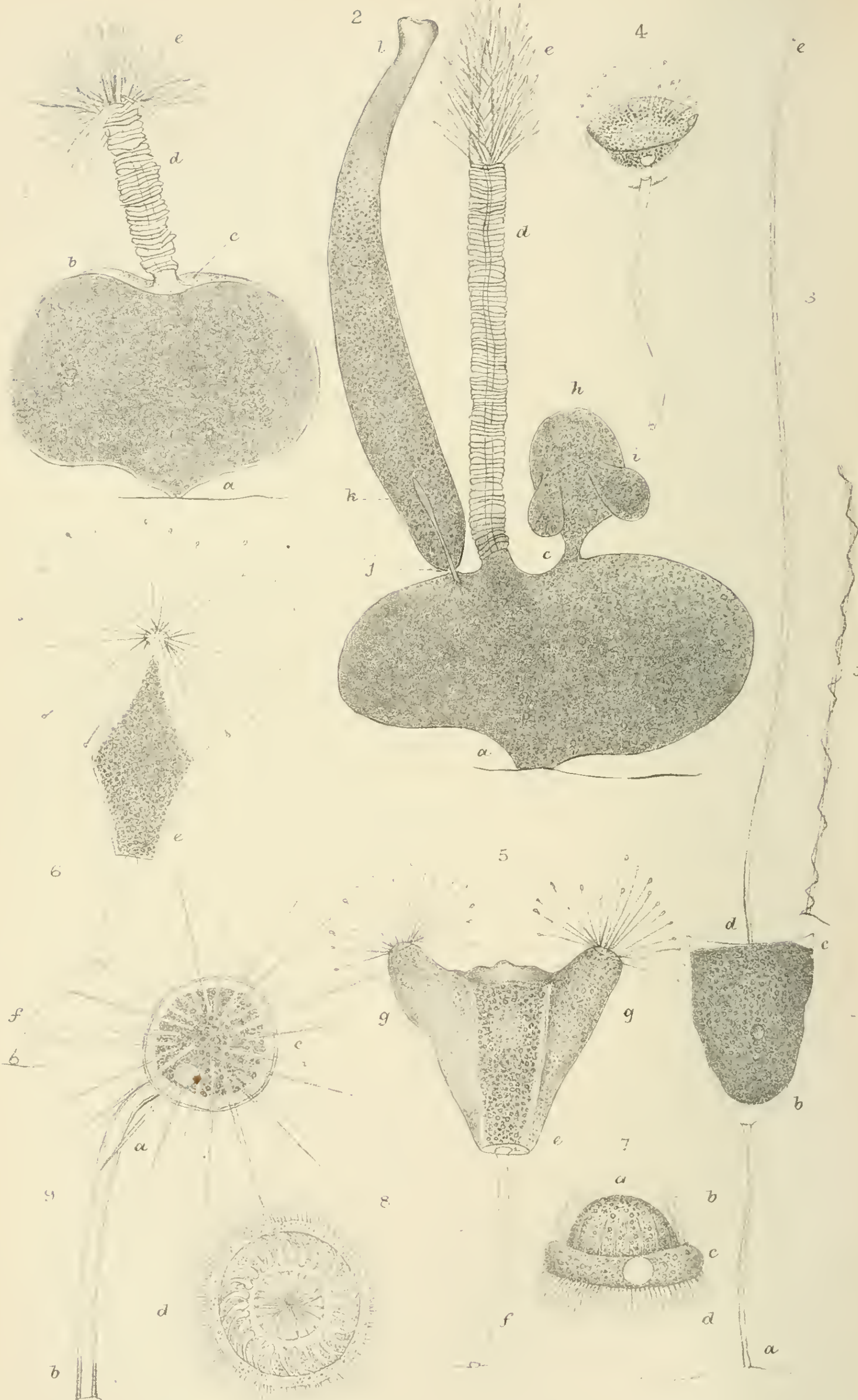
Fig. 3.—*Acinetopsis rara* Ch. R. *a*, pedicle; *b*, *c*, theca; *d*, *e*, *f*, extensile and retractile tentacle.

Fig. 4.—*Acineta patula* Ehr., the body of which is suspended as it were in its shell, which resembles a pedicellated cup.

Fig. 5.—*Acineta tuberosa* Ehr., front view. *f*, the pedicle and its insertion at the lower extremity of the body, *e*; *g*, *g*, tubercles.

Fig. 6.—Side view of the same.

Fig. 7.—*Trichodina Scorpenæ* Ch. R., side view. *a*, superior dorsal or contractile portion of the body, often more or less contracted and flattened; *b*, crown



West Newman & C° lith

Fig 1-2. Ophryodendron abietinum. 3. Acinetopsis rara.
4. Acineta patula. 5-6. A. tuberosa 7-8. Trichodina Scorpenæ.
9. Podophrya Lyngbei.

West Newman & Co lith.

Fig. 10–14. Podophrya. 15 Conodosiga botrytis.

body superficially into two unequal halves, being seldom wanting. It shows an extraordinary resistance to the action of reagents, even hydrochloric and nitric acids merely hardening and rendering it more transparent! Its substance is greyish and granular, more transparent towards the surface, where it is limited by a tough, flexible, refringent layer, not separable from it, and from ·001–·002 mm. in thickness. The only organized contents consist of minute granules, which have no resemblance to trichocysts. Buds ($c$, $h$) bearing superficial protuberances ($i$) are produced; their tissues are directly continued from those of the parent. The tentacle is inserted in the groove or the portion furthest from the pedicle if that is not present; the cuticle of the body is continued over it, being wrinkled ($d$) when it contracts, and also forms a distinct band in the centre of the tentacle; that part

of large cilia; *c*, non-contractile discoid portion of the body with the pulsatile vesicle; *d*, lower crown of fine locomotor cilia.

Fig. 8.—Lower concave face of the same, surrounded by the crown of locomotor cilia, *d*, and occupied by the indented wheel-like organ.

Fig. 9.—*Podophrya Lyngbyei* Ehr., front view. *a*, the insertion of the pedicle, *a b*; *c*, transparent theca, the margin of which extends beyond the granular substance of the body—the latter shows a pulsatile vesicle and hyaline expansions.

Fig. 10.—*Podophrya* with four gemmæ, *e*, about one quarter developed.

Fig. 11.—Large *Podophrya* with eight gemmæ, *e*, at the close of their development, the extended filaments not having completely disappeared. The margin of the internal concave face of the gemmæ has also short mobile cilia. In each gemma are one, two, or sometimes three pulsatile vesicles.

Fig. 12.—Phases of the passage of a gemma to the state of a fixed pedicellate *Podophrya*.

*a*, gemma becoming fixed, still provided with cilia, *i*, and with a verrucose dorsal face.

*b*, the same, a quarter of an hour later, attached directly by its lower face and not showing any cilia.

*c*, the same, twelve or fifteen minutes later, elevating its two extremities, and the dorsal face emitting some pale and short filaments.

*d*, *e*, the same, at the end of two successive quarters of an hour.

*f*, the same, fifteen minutes later, having already assumed the general form of the adult and still directly fixed to the Sertularia by the narrow portion, *j*, where the pedicle is inserted.

*g*, the same, about twenty minutes later, with longer and more numerous filaments, some already pointed. A short pedicle, *k*, is developed, and the body resembles still more nearly the adult.

*h*, the same, half an hour later, differing from the adult only by the shortness of the pedicle, *l*, and the few coloured granules of the body.

Fig. 13.—*Podophrya* with the body, *c*, reduced to small dimensions after the loss of the gemmæ and recommencing to throw out filaments, still short and blunt, *c*.

Fig. 14.—*Podophrya*, with a non-ciliated external gemma, *i*, and a bundle of short filaments or blunted suckers, *h*. *a*, *b*, pedicle.

Fig. 15.—Variety of *Codonosiga botrytis* Stein *ex* Ehrenberg, with four rigid cirrhi, *f*, instead of a collar.

*a*, enlargement of the base of the pedicle attached to stationary bodies in the water; *b*, thickening of the summit of the pedicle which bears the body of each animal; *e*, individual with the rigid cirrhi united by a membrane forming a collar; *f*, the four stiff cirrhi inserted round the upper portion of the animal so as to resemble hyaline opercula; *i*, thin circular membrane in the form of a slightly raised cup inserted on the hyaline operculum round the base of the flagellum, alternately contracting and dilating; *j*, the flagellum, four to six times as long as the body, and as large at its termination, which is blunt, as at its insertion in the middle of the hyaline opercular summit.

[In the lettering of the Plates for "Lyngbei" read "Lyngbyei," and for "Conodosiga" read "Codonosiga."]

of the body-substance which extends into the tentacle here loses its granular character, and is simply hyaline. The tentacle is of equal length as far as the tuft of cirrhi; it is flattened. The colourless cirrhi have the form of pine-needles, are ·03 mm. long, and occur to the number of thirty or more; in the extended state of the tentacle they are inserted along one-fifth of its length; in contraction they are reduced to a mere tuft. They are firmly attached, and, like the rest of the organism, resist the action of ordinary reagents. Contraction and elongation take place in the tentacle at intervals of two minutes; the cirrhi move rapidly at the same time, either by bending or otherwise, but not after the manner of either cilia or flagella. No use was observed to be made of these movements for prehension of food, which M. Robin has never noticed taken into the body.

The affinity of the animal is with *Acinetopsis rara.* The cirrhi can hardly act as suckers, as Claparède supposes, for they are flattened and more mobile than the suckers of the Acinetines, and terminate neither in a point nor a swelling as in those forms.

*Worm parasitic on Ophryodendron* (Fig. 2). A vermiform body ($l$) sometimes occurs, rooted to the body of the animal, which has been supposed by Claparède to be a species or stage of the same animal, and in which he wrongly figures trichocysts; Wright took it to be either a bud or one of the Gregarinida. It is, however, M. Robin considers, a larva of some worm; its tissues differ in character from those of *Ophryodendron;* it is separable from it without rupture, and is fixed by a special attaching organ; it wants the nucleus and vacuole of the Gregarinæ. The basal organ of attachment ($j$, $k$) consists of a slender chitinous rod embedded in the worm, with five or six short hooks which penetrate beneath the cuticle of its host near the tentacle. The body is greyish and finely granular, and is transparent at the anterior end, which has a sucker-like enlargement; the proximal end bears an oblique disk-like surface; dilute hydrochloric acid causes its substance to shrink and expose a homogeneous cuticle to view. It moves slowly round on its peduncle, and resembles in some points the filarian larvæ of many Nematode worms.

*Acinetopsis rara* sp. n. (Fig. 3), discovered by M. Robin at Concarneau, is also a tentaculate Infusorium. It occurs attached to Sertularians, is from ·07–·09 mm. long, and two-thirds as broad, and lives in a wine-glass-shaped theca ($b$, $c$), which rests on a very slender peduncle ($a$), 1 mm. long. The body is uniformly granular, greyish, with a small contractile vesicle; upper surface flat, an alternately extended contractile tentacle ($d$, $e$) proceeding from its centre. The tentacle, which measures 1 mm. or more in length by ·004–·005 mm. in thickness, is of uniform thickness throughout, and colourless, homogeneous, and transparent; by contraction it is reduced to a length of ·05–·08 mm., with a breadth of ·01 mm., becomes marked by transverse striæ, and is now seen to consist of a central filament, surrounded by a spirally plicated membrane ($f$). In extension, it is capable of movement in all directions. The shell or theca is continuous with the substance of the peduncle, and is delicate, colourless, flexible, and has a free circular edge, beyond which the body is never protruded, though it may sink below it, and may become detached from the theca at various points. The contractile vesicle is only momentarily seen.

This form differs from the Acinetinæ in possessing a tentacle which is never retracted into the body wholly or in part, as is the case with the suckers in that group, but which agrees, with the exception of the absence of cirrhi, with that of *Ophryodendron.* Both forms must be kept distinct from that family.

*Acineta tuberosa* Ehrb. (Figs. 5 and 6, *e, f*) offers a good example of the great affinity of its order with the Infusoria and disagreement with the Rhizopoda, the characters of the gemmæ giving grounds for the one, and the distinctness from the rest of the body and the special character of the suckers for the latter inference. The variations in its colour are due to the presence of pale yellow, green, or orange granules. Frequent contractions of the sarcode remove these granules from different points which are thus left transparent; the narrow portion, however, between the two tubercles (*g, g*) is almost constantly thus transparent; it contains the one or two contractile vacuoles; but the central part of the body is generally the most granular, and is marked off from the lateral portions by two longitudinal ridges on each side of the shell; these ridges are absent in *A. patula* (Fig. 4), hence the difference in the grouping of the suckers in the two species, the body not being divided into separate areas. A species found in stale sea-water had the lower end of the shell rounded; the upper angles presented, instead of two tubercles, simply two perforations of the shell.

*Trichodina Scorpenæ* sp. n. (Figs. 7 and 8) does not exceed half the size of *T. pediculus* auctt.; it occurs on the branchiæ of fish of the genera *Scorpena* and *Trigla.* It is disk-shaped, the ventral side concave, a narrower dome-like mass (*a*) rising above the disk (*c*); the only cilia present consist of a ring of stout ones (*b*) projecting upwards from the upper edge of the disk, and one of fine ones (*d*) in a corresponding position on the lower side, the latter marking the margin of the denticulated plate described as "organ of fixation" by Claparède and Lachmann. This organ consists of a narrow circle, into the centre of which project numerous straight teeth, while the circumference is lined by curved ones (Fig. 8). The body and this organ especially undergo great changes after death, which occurs soon after that of the host.

*Gemmation of Podophrya Lyngbyei* Ehrb. (Plates XVIII. and XIX., Figs. 9–14). The body substance of this species, wrongly referred to *P. gemmipara* by Hertwig, is not separable to the slightest extent from the shell or theca, though this is readily distinguishable from it by its contours, its folds, and its resistance to agents which destroy the former. The nucleus is elongated and curved, often bi- or tri-furcate. In encysted individuals the substance of the body is withdrawn slightly from contact with the cyst. The peduncle (*a, b*) has a very delicate wall, and is homogeneous, rarely manifesting a longitudinal striation.

The *external* buds commence as a hyaline cup of sarcode on the upper surface of the body (*c*), in a vacant space surrounded by the suckers; after a few minutes this sends out a number of conical elevations (*e*) regularly arranged in a circle; they are transparent, and after a few hours become detached and swim freely. From two to eight may thus be produced; they are finely granular, become elongated, and on their concave internal face appears a series of short cilia; it is in about half an hour from this time that they are liberated, and may either crawl or swim by the aid of these cilia. The suckers of the parent are sometimes wholly retracted during the process, and are subsequently reproduced from the dense, shrunken body (Fig. 13, *c*, *e*). These buds are of truly external origin, the only peculiar condition noticed inside the parent body at this time being the prolongation of its nucleus into as many filaments as there are buds, as in the case of the internal gemmæ. The dorsal surface of the bud is convex; there are two contractile vacuoles, one appearing at the middle of the process of gemmation; the nucleus is about ·012 mm. long, and pale-coloured. The bud ceases crawling (Fig. 12, *a*), and after resting, fixed by its cilia (*i*), for a short time, it loses these, and becomes attached by its entire ventral face (*b*); the two lateral margins then become slightly drawn out, and short processes (*c*) appear on the upper surface; the ventral surface becomes contracted (*d*, *e*, *f*) until it forms a peduncle (*j*), the upper surface, which now bears transparent, but soft, rays, becoming regularly circular; a delicate hyaline pellicle then appears on the circumference of the body. The peduncle proper appears last, without any apparent origin from the substance of the body, as a narrow hyaline disk at its base; it then becomes a short non-nucleated capsule with distinct walls (*g*, *h*, *k*, *l*), ultimately elongating to assume its final shape.

Another form of bud (Fig. 14, *l*) is observed, but less commonly, at the same period. When first seen, it formed a cylindrical process in the calyx, was finely granular, contained one or two contractile vacuoles, and bore a few short rays (*h*); it then elongated itself, having a basal strand of substance connecting it with the adult, whose cup-like form it takes; it moves with ease on its pedicle in this position, but though readily detached, its future history was not traced.

Variety of *Codonosiga botrytis* Stein *ex* Ehrb. (Fig. 15). This form often has a branched pedicle, the secondary pedicles starting from the top of the primary one; each carries an individual, and their number never exceeds four, and, like the top of the chief one, they are thicker than the stem. The hyaline, finely granular body substance contains some special refracting granules, ·001–·002 mm. broad. To a small elevation at the anterior end are attached four short, stiff cirrhi (*f*), half the length of the body, in some cases united by a delicate membrane so as to form a collar (*e*). In some individuals the base of the flagellum (*j*) is surrounded by a short cup-shaped process (*i*) which may be either homogeneous or longitudinally striated and is alternately protruded and retracted; it has not been observed before. The flagellum ends bluntly. There is no shell, the body and pedicle dissolving rapidly in ammonia.

The variety has probably been already figured by Fromentel and Jobard-Muteau as *Pycnobryon*, and described by Bory de Saint Vincent as *Autophysa*. These Flagellata are clearly distinct from the Vorticellina. The cirrhi are homologous with the collar, for the two organs replace each other.

**Radiolaria in "Diaspro."***—Prof. Dante Pantanelli announces the discovery of Radiolaria in the Italian "diaspro" from various places, and of different ages; two from the lias, and one probably cretaceous, but the greater number were from the upper eocene. Professor de Stefani, in speaking of this diaspro and manganite at a previous meeting of the Pisa Society, attributed their formation to deposits in deep seas; but this idea was combated, and in consequence Professor Pantanelli undertook the examination, with the above results. The importance of this is much increased by the fact that the diaspro of Murio and Crevole are intercalated with the serpentine, and it may be hoped that much light will thus be definitely thrown on a question which is occupying much attention in Italy, and has also been taken up by some of our leading English geologists—the formation of the Italian serpentines. Professor Pantanelli thinks we may now definitely accept the hypothesis of Stoppani, that the serpentines are volcanic rocks, for the most part erupted in deep seas. Thus the same conclusion is arrived at from quite different standpoints. He also thinks it may facilitate an explanation of the mode of formation of manganese deposits, as they occur in connection with the diaspro rich in fossils, and hints that it would make us doubt the possibility of their being formed by an endogenous action, or from deposits of mineral water.

Professor de Stefani called attention to the use the Microscope may now be to anthropologists, in showing from what locality implements made of this rock were derived.

Mr. A. W. Waters believes he is in a position to refer to the Eocene "diaspro" the rock mentioned by Professor Bonney,† in which attention was called to its containing fossils which Professor Bonney was himself inclined to refer to Radiolaria and Bryozoa. Professor Pantanelli has in the press an article describing a large number of the Radiolaria observed.

---

## BOTANY.

### A. GENERAL, including Embryology and Histology of the Phanerogamia.

**Development of the Embryo-sac.**‡—Dr. A. Fischer publishes the results of a large series of observations on the development of the embryo-sac, especially in monocotyledons and in dialypetalous dicotyledons. The following are the more important of the conclusions at which he has arrived.

* 'Boll. R. Com. Geol. d'Ital.,' 1880, Nos. 1, 2. See 'Geol. Mag.,' vii. (1880) p. 317.

† 'Geol. Mag.,' vi. (1879) p. 369.

‡ 'Jenaische Zeitschr. f. Naturwiss.,' xiv. (1880) p. 90.

The three nuclei in the chalazal end of the embryo-sac around which the antipodals are subsequently formed, are termed by Fischer the *antipodal nuclei;* the fourth nucleus is called the *lower polar nucleus;* the two sister nuclei in the upper end of the embryo-sac which are taken up into the synergidæ, are denominated *synerg-nuclei;* the two others, the *germinal nucleus* and the *lower polar nucleus*, according as they subsequently form the embryo or unite with the lower polar nucleus; the product of this union may be called the *central nucleus* of the embryo-sac.

In monocotyledons a very great uniformity was observed in the development of the groups of cells in the end of the embryo-sac, and in the origin of the central nucleus. The cells of the germinal apparatus are always formed in threes, and never multiply. Two synergidæ are always produced, the nuclei of which stand to one another as sister-cells, in the same relation as the germinal nucleus to the upper polar nucleus. The two synergidæ are usually inserted at the apex, with exceptions in the cases of *Sesleria* and *Allium fistulosum.* The mode of attachment of the germinal nucleus is subject to greater variations. Thus we find it inserted into the wall of the embryo-sac beneath the synergidæ, apparently attached to them, in *Luzula*, *Triglochin*, *Carex*, *Alisma*, *Elodea*, and *Nothoscordum.* In *Alopecurus*, *Melica*, *Orchis*, *Gymnadenia*, *Ornithogalum*, *Gladiolus*, *Crocus vernus*, and *Funkia*, the germinal nucleus is attached to the apex of the embryo-sac in the same way as the synergidæ, so that it appears to be covered by them, or to lie upon them, according to the side from which the observation is made. Special interest is attached to the arrangements in *Sesleria* and *Allium fistulosum*, with which *Ehrharta* agrees in some respects.

The antipodals always originate in threes. They have but a transitory existence in *Alisma*, *Triglochin*, *Orchis*, and a majority of the monocotyledons examined. Those of the Gramineæ are distinguished by the extent to which they divide, and by their comparatively late resorption.

The union of the two polar nuclei takes place in two ways. In one case the two nuclei approach one another, and the coalescence takes place in the centre of the embryo-sac; in the other case the upper of the two remains stationary, and the lower one passes completely across the embryo-sac. The former occurs in *Luzula*, *Alisma*, *Carex*, *Triglochin*, *Orchis*, *Ornithogalum*, and *Nothoscordum;* the latter in *Elodea*, Gramineæ, and *Allium fistulosum.* The coalescence usually takes place before impregnation; but in *Alisma* and *Allium fistulosum* only during the contact of the pollen-tube, or even after impregnation has been completely effected.

The formation of "tapeten-cells" was observed only in *Luzula* and *Triglochin.* The mother-cell springs from the subepidermal layer in *Elodea*, *Alisma*, *Triglochin*, *Luzula*, and Gramineæ; in *Carex* from a deeper layer of the nucellus. In *Alisma* and *Allium fistulosum* the activity of the mother-cell is exhausted in the formation of primary daughter-cells. In *Gymnadenia*, *Orchis*, and *Anthericum* three cells are formed by further division of the lower of these daughter-cells; while four secondary daughter-cells are developed from the mother-cell in Gramineæ, *Elodea*, *Triglochin*, *Carex*, *Luzula*, *Tritonia*, *Sisyrinchium*, and *Hemerocallis*.

The walls which separate the daughter-cells, especially that which is formed first, are marked by a strong power of swelling. In all cases the lowest daughter-cell shows considerable increase in size at an early period. It is this only which always develops into the embryo-sac. Two sacs in a single ovule were once observed in *Triglochin*.

In the dialypetalæ, as in monocotyledons, the mode of formation of the cells in the embryo-sac is remarkably constant. The insertion of the two synergidæ in its apex exhibits no variation in any species examined.

In anatropous ovules the germinal nucleus appears as if fixed to the synergidæ, but is in fact inserted somewhat lower down on the wall of the embryo-sac, and is partly covered by the synergidæ. The only exception observed was in *Hippuris*, where the position of the germinal nucleus was always lateral.

The same regularity recurs in the synergidæ always appearing in pairs, and in the presence of a single germinal nucleus; the only instances in which two germinal nuclei were observed are *Gomphrena* and *Santalum album*.

A reduction in number of the synergidæ to one occurs occasionally as an abnormality. The antipodals are always formed in threes; in only a single case was a greater number observed, or of their nuclei. They attain a very powerful development in *Delphinium* and *Allionia*; but are transitory and fully developed in *Chenopodium*, *Helianthemum*, and *Hippuris*.

The central nucleus is always formed by coalescence of the two polar nuclei. Of these either both are motile, meeting in the centre of the embryo-sac, or the upper one remains stationary, and awaits the approach of the lower one. The former occurs in *Delphinium*, *Myosurus*, *Ribes*, *Cydonia*, *Geum*, and *Rubus*; the latter in the Centrospermæ, *Helianthemum*, *Hippuris*, *Sanguisorba*, and *Agrimonia*.

The mother-cell of the embryo-sac always originates, in dialypetalæ, from the subepidermal layer, which attains in this class its greatest differentiation; and a resemblance is thus exhibited, through *Hippuris*, to the behaviour in the gamopetalæ. Tapeten-cells are not always given off; but a uniform behaviour is often to be observed in large circles of affinity, as in the Centrospermæ. In *Chenopodium* the division of these cells takes considerable part in the structure of the nucellus.

The epidermis remains single in a great number of cases; although a periclinal increase of its elements occurs frequently. The divisions are still more copious in *Delphinium*, *Helianthemum*, and Rosaceæ, where they assist the growth of the apex of the nucellus. *Hippuris* exhibited a peculiar behaviour of the epidermis, resembling that in the gamopetalæ.

As a rule, only a single embryo-sac mother-cell is formed, as in Centrospermæ, Ranunculaceæ, and *Ribes*, though a doubling takes place occasionally. In *Helianthemum* and Rosaceæ several mother-cells are produced regularly, with originally equal power of development, until one of them, usually the central one, attains the upper hand, so that finally only a single embryo-sac is produced.

In *Chenopodium* and *Sabulina* only primary daughter-cells proceed from the mother-cell. By division of the lower of these a row of three cells is produced in *Allionia*, *Gomphrena*, *Cydonia*, *Geum*, and *Myosurus*, exceptionally in *Chenopodium*. Four secondary daughter-cells appear in *Delphinium*, *Ribes*, *Helianthemum* (in this case as many as six), *Sanguisorba*, *Rubus*, *Polygonum*, and *Hippuris*. In dialypetalæ it is always the lowest cell of the row of daughter-cells, whatever their number, and this only, which develops into the embryo-sac; the only exception at present known occurring in *Rosa livida*.

Fertilization of Cobæa penduliflora.*—Mr. A. Ernst, writing from Carácas, describes his observations showing the peculiar circumstances under which the flowers of this plant are fertilized.

The flowers have little to attract attention, being dull green in colour, with very little red on the filaments, and no smell. The plant climbs in the same manner as *C. scandens*, described in Darwin's 'Climbing Plants.' The flowers grow on long peduncles, which generally have a horizontal position, projecting some five or six inches from the mass of the foliage. When the calyx opens, the filaments as well as the style are irregularly twisted; but in about two or three days all become straight. The style hangs obliquely downwards; the filaments all bend sideways, the bend being inside the tube of the corolla, a little over the hairs at their base. There is often a distance of 15 cm. between the anthers of either side. About 5 or 6 P.M. the anthers burst, and soon after the style rises and assumes a central position, so that there is a distance of about 10 cm. between the stigmas and any of the anthers. *Only then* is nectar being secreted (very copiously) by the glandular disk round the base of the ovary, and it appears therefore when the anthers have done their work; even an hour before their rupture no trace of it is to be found. The nectar-cavity in the tube of the corolla is completely shut up by the numerous spreading hairs at the base of the filaments, so that an overflow is impossible. The grains of pollen are very large (0·2 mm. in diameter) and of the same structure as in *Cobæa scandens*.

Several weeks passed at first before the manner of fertilization was witnessed. The stigmas were every morning carefully examined, but no pollen could be discovered on them. The filaments twisted back again and got somewhat frizzled, after one single night's expansion. About noon the corolla drops off, separating from close to the glandular ring, and then slipping down over the style, which, by this time, is again in a relaxed hanging position. There is always some nectar in the tube of the corolla after its separation, but none remains in the calyx round the ovary, nor does its secretion continue.

* 'Nature,' xxii. (1880) p. 148.

This shows that the fertilization must take place in the same night after the bursting of the anthers, and it was but natural to suppose that it was effected by nocturnal moths. It would appear, furthermore, that *the nectar is not of any direct advantage to the plant*, as M. G. Bonnier emphatically affirms,* because of its being produced and lost in all flowers, fertilized or not, in the same way.

As soon as the number of flowers increased (on some evenings twenty to twenty-five had their anthers opened), most of them were found every morning with pollen on the stigmas; and keeping a close watch, it was discovered that the plant was visited by several large Sphingidæ belonging to the genera *Chærocampa*, *Diludia*, and *Amphonyx*. All of them proceeded in the same manner. Holding the body close over the style, they dipped their spiral tongues into the tube of the corolla, beating all the while the anthers so violently with the tips of their fore-wings that they dangled about with great velocity in every direction. The grains of pollen being covered by a sticky substance, many of them adhered to the wings. An *Amphonyx*, after having visited six flowers consecutively, had the tips of the fore-wings almost yellow with pollen. When leaving a flower for another one, some of this pollen is even lost on the foliage, but by the time the insect takes its central position before the flower the stigmas are likewise touched by the wings, and thus some pollen is left on them. Some flowers remain without being fertilized, especially in places where the moths cannot reach them easily. All flowers fertilized in this manner set fruit very soon; but no flower gave a fruit without having its stigmas pollinized by crossing.

Self-fertilization is therefore excluded, and this is further proved by the following experiments:—Twelve flowers were artificially fertilized by their own pollen and afterwards protected by muslin bags; only in one case was a fruit obtained; but it is doubtful whether some foreign pollen did not reach the stigmas of this flower. Cross-fertilization was likewise tried in twelve flowers, nine being experimented on in the same evening after the opening of the anthers, and three the next morning. All the former are now with fruit; the latter remained sterile. This fact shows how very short is the period of possible fertilization.

Flowers visited by nocturnal moths are as a rule either large and of white colour, or have a strong smell; but in this *Cobæa* the former is certainly not the case, and no smell could be discovered. But it is well known that insects, especially Lepidoptera, have in this respect a really wonderful keenness, which enables them to track a scent absolutely imperceptible to man.

Structure and Motile Properties of Protoplasm.†—According to C. Frommann, the protoplasm of the vegetable cell, which often appears quite homogeneous, has a reticulate structure, as also have the chlorophyll-grains. This structure was seen especially clearly in

* 'Ann. Sci. Nat. Bot.,' viii. (1879) p. 206.

† 'Beob. üb. Structur u. Bewegung-erscheinungen des Protoplasm der Pflanzenzelle,' von C. Frommann, Jena, 1880. See 'Bot. Centralbl.,' i. (1880) p. 183.

the epidermal cells of *Rhododendron ponticum* and *Dracæna Draco.* The cells are usually not entirely filled with protoplasm; roundish lumps or striated layers mostly lie near the cell-wall. In the mass lie larger granules, and these form the knots which are connected with one another by nets of fine threads with very narrow round, oval, or angular masses. This reticulate structure of the protoplasm varies in form and distinctness.

The cell-wall also exhibits a filamentous structure; the reticulations appear gradually to pass over into the substance of the cell-wall. Two adjoining cells usually communicate with one another by means of cavities and crevices which are traversed by granules and threads; so that the cells are thus closely connected together by the uniting threads of protoplasm. The contents of the canals are often to be clearly made out, but are often scarcely to be distinguished from the cell-wall, since they may gradually acquire the same refractive power as the cell-wall. Chlorophyll-grains and coloured portions of the reticulations are also found, not only in the cavities of the division-walls, but even in their substance. The cuticle of the cells is also not homogeneous, but exhibits reticulate and granular deposits. The same is also the case with the hypodermal cells; but among their contents are found also small roundish granules with a reticulate structure. A similar structure was manifested by *Aloë arborescens*, *Crocus*, *Hyacinthus*, and *Mentha.*

The origin of the reticulate from homogeneous protoplasm can be readily followed out in the aleurone grains in swollen seeds of *Lupinus Parkeri;* within the same cell the transition takes place from homogeneous aleurone grains to grains with a scarcely perceptible, and then to those with an evident reticulation. The behaviour of the threads of the network when starch-grains are being developed can be investigated in the chlorophyll-grains of *Aloë.* In the skeleton of the network lie separate roundish bodies, which are coloured blue by iodine; while in other chlorophyll-grains the threads of the network are themselves coloured blue by iodine, showing that their substance is gradually transformed into starch.

**Structure of Sieve-tubes.***—Previous investigations of the structure and development of sieve-tubes have been carried out only in the cases of *Pinus sylvestris* and *P. Laricio*, which agree in every detail. E. Janczewski has now extended his observations to other Coniferæ, as also to the Gnetaceæ and Cycadeæ.

The bast of gymnosperms always contains numerous sieve-tubes of uniform shape; they are prismatic, their terminal walls being strongly oblique. The tangential walls of the sieve-tubes are perfectly smooth, but the radial walls are provided with more or less thick, the terminal walls with especially thick, sieve-plates. These sieve-plates have a roundish form and sharp boundaries, when the cell-wall of the sieve-tube is sufficiently thick and passes suddenly into the sieve-plate, as in *Pinus* and *Abies.* When, on the contrary,

* 'SB. k. Akad. Wiss. Krakau, Math.-naturw. Sect.,' vii. (1880) p. 29. See 'Bot. Centralbl.,' i. (1880) p. 485.

the cell-wall is much thinner, not varying greatly in thickness from the sieve-plate itself, the transition into the sieve-plate is more gradual, the boundaries of the latter being less striking to the eye, and the form of the sieve-plate is altered, being divided by striæ of the cell-wall into smaller plates more or less separated from one another, as in *Gingko*, *Gnetum*, *Ephedra*, and *Cycas*. Mature sieve-plates contain no protoplasm in their interior, and are not subject to any changes from the season. Their pores are always uncovered, and, as in angiosperms, completely perforated.

The sieve-plates arise from the membrane of the bordered pits which are in the cambial cells on their radial and terminal walls. The membrane of these bordered pits swells up, is considerably altered in structure and in chemical composition, and finally forms on both sides a thick callus, within which is the sieve-plate, which is exposed by the absorption of the callus.

Since the protoplasm disappears from the sieve-tubes immediately after they are set free, nothing can at present be satisfactorily determined respecting their physiological purpose and the period of their activity.

The sieve-tubes of gymnosperms are therefore homologous to those of angiosperms, but differ from the latter, both in the mode of development of their sieve-plates, in the absence of protoplasm from them when mature, and also in the constancy in form of the sieve-plates at all periods of the year.

**Chemical Composition of Chlorophyll.***—R. Sacchse, of Leipzig, publishes some fresh results of phyto-chemical investigations on the composition of chlorophyll. By means of a peculiar method he has succeeded in separating both the green and the yellow pigment from the benzin-extracts of leaves, in *Allium ursinum* and *Primula elatior*, in a pure state, though perhaps not altogether unchanged from the chlorophyll in a functional condition.

Contrary to expectation the green pigment was found not to be homogeneous, but capable of separation into five distinct chemical substances, resembling one another closely in optical properties, but varying in quantitative composition. The proportion of carbon varies between about 66 and 72 per cent., that of nitrogen between about 3 and 5·5 per cent.

Similar results were obtained with the yellow pigment. In this also were found at least four distinct chemical substances, varying in colour from yellow to reddish brown, of a similar fatty nature, and similar spectroscopic properties, but varying in chemical composition. They are all non-nitrogenous, while the proportion of carbon varies between about 66 and 71 per cent. Each of the green pigments has a corresponding yellow pigment with the same carbon-percentage, but destitute of nitrogen.

In addition to the green and yellow pigments there was found a remarkable substance, agreeing nearly with starch in its carbon-

* 'Phytochem. Untersuch. herausg. v. R. Sacchse,' i. (1880) p. 1. See 'Bot. Centralbl.,' i. (1880) p. 519.

percentage, but distinguished by containing a considerably greater quantity of water, and only partially converted into sugar by the action of acids. The author has not been able to determine whether this is an accidental accompaniment to the pigments, or what is its relation to chlorophyll.

**Composition of Chlorophyll.***—Hoppe-Seyler publishes a continuation of his work on chlorophyllan,† a crystalline substance closely resembling chlorophyll, obtained from green grass. By treatment with alcoholic potash, chlorophyllan yields, amongst other products, an acid characterized by giving a splendid purple-coloured ethereal solution, which exhibits very marked rose-red fluorescence. For this compound—$C_{20}H_{34}O_3$—Hoppe-Seyler proposes the name of *dichromatic acid.* The absorption spectrum of the acid in ethereal solution is marked by two bands between C and D, whilst the spectrum of the fluorescent light from the same solution exhibits two bright bands in exactly the same positions.

**Division of Chlorophyll-grains.‡**—J. Schaarschmidt summarizes the observations of recent writers on the division of chlorophyll, adding some also of his own. He states the general results obtained to be that the chlorophyll-grain is capable of division in all plants; that the division is not effected at any particular time of the year; and that it takes place in the same manner as the cell-nucleus, in two ways; most usually by a median zone and the formation of numerous threads of protoplasm; or by the formation simply of numerous threads of protoplasm, in which case no formation of a median zone takes place.

The author enumerates 22 species of cryptogams, and 38 of phanerogams, in which the division has been observed either by himself or others. He claims to have observed that the surface of the chlorophyll-grains is furnished with extremely fine cilia which are usually placed at equal distances apart, and are colourless. They were first observed in *Boehmeria biloba*, most distinctly in *Hartwegia comosa.*

**Branching of Endogenous Organs from the Mother-organ.§**—An elaborate paper on this subject by H. Vonhöne concludes with the following summary of results:—

1. From the young root a secretion is given off which acts as a solvent on the tissue of the mother-organ, destroying first the turgidity of the cells, and then their primordial utricle, and thus making way for the root.

2. When the secretion cannot act in consequence of the nature of the cell-wall, the quickly growing root exercises a mechanical pressure on the obstructive tissue. In this respect there is a difference in the behaviour of different kinds of tissue.

* 'Zeitschr. physiol. Chemie.' See 'Nature,' xxii. (1880) p. 279.

† See this Journal, *ante*, pp. 116 and 296.

‡ 'Magyar Növénytani Lapok,' iv. (1880) p. 33. See 'Bot. Centralbl.,' i. (1880) p. 457.

§ 'Flora,' lxiii. (1880) p. 227.

*a*. Thick-walled parenchyma and bast are simply stretched, and then ruptured.

*b*. The epidermis and collenchymatous cells continue to grow for a time together with the root, and are only subsequently overtaken and broken through by it.

3. In consequence of the increase in thickness, a union in growth takes place between the root and the adjoining tissue of the mother-organ, when the latter is still in a formative condition.

4. The subsequent increase in length of the cells of the root causes also the innermost cortical cells of the mother-organ, which are in anatomical connection with the root, to become stretched radially. At the same time the true increase in thickness causes the cortical cells to form curves parallel to the surface of the root. In consequence of the similarity of the cells which form the curves, curves crossing each other at right angles are also seen; and hence the root appears to run out from a broad base, while in fact it is considerably contracted below.

**Influence of Direction and Strength of Illumination on certain Motile Phenomena in Plants.***—E. Stahl's paper on this subject contains the following general observations:—

The effects of light in this respect are very various. Sometimes formed cell-contents, as chlorophyll-grains, in the interior of the protoplasm, are set in motion, and carried within the cell-cavity to places which indicate a definite relation to the direction of the rays of light. In other cases the influence of the light is exhibited, not in the direction of certain particles, but of entire free motile organs.

In spite of differences in particular cases, a general and important phenomenon is evident, that, when other conditions are the same, especially where the direction of the light remains the same, the variations in sensitiveness to light depend entirely on the intensity of the light.

When the direction remains the same, the chlorophyll-plate of *Mesocarpus* places itself at right angles to this direction when the illumination is weak; but, when the intensity passes a certain limit, the plate turns through an angle of 90°, and places itself in the direction of the rays. A swarmspore usually turns its anterior end to weaker light, the reverse when the light is stronger. This is true both in the case of positively heliotropic filaments and of those which grow at right angles to the direction of the light. The behaviour of species of *Closterium* varies with the intensity of the light; and the same is true for diatoms, and, according to older observations, for Oscillatorieæ and Myxomycetes.

The varying susceptibility of vegetable protoplasm to the influence of light, which has thus been determined in a number of single cases, is of proportionate importance in determining the positions dependent on light of more complicated organs, as is illustrated in the case of *Vaucheria*. When a filament of *Vaucheria* is illuminated from one

* 'Bot. Zeit.,' xxxviii. (1880) p. 297.

side, it assumes a direction of growth at right angles to the light, so long as the illumination is of a certain intensity. If, other conditions remaining the same, the distance of the plant from the source of light is increased, an intensity is sooner or later attained at which the filament alters its direction of growth, and becomes positively heliotropic ; it grows more or less exactly towards the light. If the earlier condition is restored, the plant assumes again its previous direction. This is true both of positively heliotropic filaments and of those which grow at right angles to the direction of the light. The phenomena different from this exhibited by a plant of *Vaucheria* rooting in the ground are no doubt due to similar causes ; but the conditions have not been sufficiently investigated.

**Case of Apparent Insectivorism.*** — Professor Baillon, at a recent meeting of the Linnean Society of Paris, read the following notes :—

*Peperomia arifolia* Miq., of which the variety *argyreia* is cultivated in so many greenhouses, has the leaves more or less deeply peltate. I have seen stalks on which the peltation on certain leaves was so exaggerated as to show on a cross-section a depth of nearly 4 cm. When the concave stalks take a suitable direction, water, principally that from sprinkling, would accumulate and rest in these receptacles, so well prepared to preserve it. Many small insects would fall into the water and be drowned. Last year, when the season was warm, and when the windows of the house were often open, the number of insects was very considerable, and these, soaking in the water, gradually fell into decay, and it was remarkable that there was during this not the least sign of any putrescent odour. Those who believe in the doctrine of insect-eating plants may perhaps in this be led to find an argument favourable to such theories. They will add that the variety of colours so strikingly seen in these leaves constitutes the agent of attraction for the insects to come and be devoured.

Three reflections, each of a different sort, here present themselves :—1. Is it not remarkable that the exaggerated peltation of these leaves is in this case accompanied by an apparent insectivorism, and that the leaves of the plants known up to this time by botanists as carnivorous, owe their sac-like or horn-like forms only to an excessive peltation of their limb, as was demonstrated in the evolution of the leaves in *Sarracenia ?* † 2. How can it be considered as a proof of insectivorism, that plants like *Utricularia* grow better in a fluid containing albuminoid compounds, when other plants grow equally favourably in the same kind of fluid, which latter are never for a moment thought to be carnivorous ? 3. How do the chief priests of our science reconcile the two ideas, that the surface of the leaves of plants is unable to absorb pure water in contact with them, and that the same surface daily absorbs water charged with albuminoid substances and the like ?

* 'Nature,' xxii. (1880) p. 277. † 'Comptes Rendus,' lxxi. p. 630.

## B. CRYPTOGAMIA.

### Cryptogamia Vascularia.

**Prothallia of Ferns.***—Professor J. Sachs publishes, in the form of a supplement to the 'Botanische Zeitung' for 1880, 6 plates, comprising 120 figures, illustrative of the development of the prothallia of various ferns, found among the papers left by the late lamented young botanist Dr. H. Bauke. The following are the species illustrated:—*Platycerium grande*, *Lygodium japonicum*, *Gymnogramme tartarea*, *G. L'Herminieri*, *G. decomposita*, *Asplenium plantagineum*, *Allosorus rotundifolius*, *Davallia pyxidata*, and *Hemitelia gigantea*. There is no accompanying letterpress.

**Non-Sexual Reproduction of the Prothallium of Ferns by means of Gemmæ or Conidia.**†—It has been recorded by many observers that the prothallium of ferns can increase by the separation of normal branches formed at the apex, as well as more frequently by that of adventitious shoots detached from the margin or surface. Tuberous swellings have also been observed on the prothallium of *Gymnogramme* and *Hymenophyllum*, but their detachment and germination have not been followed out.

Professor Cramer now records the formation of true non-sexual reproductive organs on the prothallium of an (unnamed) tropical fern. The prothallia having been kept for some time in a watch-glass with water, produced green filamentous excrescences, which were found on examination to be confervoid prothallia furnished with sexual reproductive organs and with abundance of gemmæ or conidia. The whole confervoid structure was from 1 to 1·5 cm. in thickness; the separate filaments were partly expanded flat on the substratum (herpoblasts of Cramer), partly growing in an ascending direction (orthoblasts). Antheridia were frequently observed on them, archegonia only twice.

The gemmæ were produced especially at the extremities of the orthoblasts. When fully developed they had somewhat the form of a *Closterium*, consisting of a curved row of six or eight or more cells rich in chlorophyll and starch, and of a bright green colour. In course of time they became detached, and in some cases gave birth to secondary gemmæ; in other cases they directly bore antheridia.

Professor Cramer compares this production of secondary protonema-like prothallia in ferns to a similar well-known phenomenon in Hepaticæ. From a phylogenetic point of view he considers that it indicates the origin of vascular cryptogams and mosses by parallel lines of descent from algoid plants, rather than the direct descent of the former from the latter.

**Amphibious Nature of the Prothallium of Polypodiaceæ.**‡—Dr. A. Dodel-Port describes the peculiar behaviour of prothallia of *Aspidium filix-mas* and *violasceus* which he had kept for a lengthened

* Aus dem botanischen Nachlasse von Dr. H. Bauke; supplement to 'Bot. Zeit.,' xxxviii. (1880).

† 'Denkschr. Schweiz. Naturf. Ges.,' xxviii. (1880).

‡ 'Kosmos,' iv. (1880) p. 11.

period beneath a cover-glass flooded with water. A part of the prothallium having decayed, there sprung from all parts of the sound portion a number of peculiar conferva- or protonema-like adventitious shoots. The production of similar adventitious shoots was easily excited in other healthy prothallia by placing them in similar conditions. After the lapse of time these adventitious shoots exhibited a tendency towards lateral branching, thus becoming secondary adventitious prothallia. This is regarded by the author as exhibiting an interesting phylogenetic affinity with the conferva-like protonema of mosses. The prothallium of a fern must be looked on as an amphibious structure intermediate in its vegetative and reproductive properties between aquatic and terrestrial structures.

**Synopsis of the Species of Isoëtes.***—Mr. J. G. Baker distinguishes 46 species, of which he gives brief diagnoses, dividing them into 4 groups as follows:—

I. AQUATICÆ.

Velum nullum. 1. *I. triquetra* A. Br. 2. *I. Gunnii* A. Br. 3. *I. elatior* F. M.

Velum partiale. 4. *I. lacustris* L. 5. *I. echinospora* Dur. 6. *I. azorica* Dur. 7. *I. pygmæa* Engelm.

Velum completum. 8. *I. Stuartii* A. Br. 9. *I. Lechleri* Metten.

II. SUBAQUATICÆ.

A. North American species, with a 2-lobed rootstock.

Velum partiale. 10. *I. Bolanderi* Engelm. 11. *I. Tuckermani* A. Br. 12. *I. saccharata* Engelm. 13. *I. riparia* Engelm.

Velum completum. 14. *I. melanospora* Engelm.

B. Australian and New Zealand Species, with a 3-lobed rootstock.

15. *I. Mülleri* A. Br. 16. *I. Kirkii* A. Br. 17. *I. alpina* Kirk. 18. *I. Drummondii* A. Br.

III. AMPHIBIÆ.

A. Rootstock 2-lobed (all North American species).

Velum partiale. 19. *I. Butleri* Engelm. 20. *I. melanopoda* J. Gay. 21. *I. Engelmanni* A. Br.

Velum completum. 22. *I. Nuttallii* A. Br. 23. *I. flaccida* Shuttlew.

B. Rootstock 3-lobed.

1. Species of the Mediterranean region:—

Velum nullum s. parum evolutum. 24. *I. setacea* Bosc. 25. *I. adspersa* A. Br. 26. *I. malinverniana* Cs. et de Not.

Velum fere s. totum completum. 27. *I. velata* A. Br. 28. *I. Peralderiana* Dur. et Letourn. 29. *I. dubia* Gennari. 30. *I. tegulensis* Gennari. 31. *I. Boryana* Dur. 32. *I. tenuissima* Boreau. 33. *I. olympica* A. Br.

2. Species of Tropical Africa:—

34. *I. Welwitschii* A. Br. 35. *I. nigritiana* A. Br. 36. *I. Schweinfurthii* A. Br. 37. *I. æquinoctialis* Welw.

* 'Trim. Journ. Bot.,' ix. (1880) pp. 65 and 105.

3. Species of Japan and Tropical Asia:—

38. *I. japonica* A. Br. 39. *I. coromandeliana* Linn. 40. *I. brachyglossa* A. Br.

4. Species of Australia:—

41. *I. tripus* A. Br.

5. Species of Tropical America:—

42. *I. amazonica* A. Br. 43. *I. cubana* Engelm. 44. *I. Gardneriana* Kunze.

IV. Terrestres.

45. *I. Duriaei* Bory. 46. *I. Hystrix* Bory.

Of these 46 species, the 3 following are new: *I. Schweinfurthii* A. Br. ms. Rootstock 3-lobed. Habit of *I. setacea*. Leaves 12–30, about a foot long, moderately firm in texture, opaque, tapering to the point, $\frac{1}{3}$–$\frac{1}{2}$ lin. diam. at the middle, furnished with stomata and accessory bast-bundles. Sporange small, globose; veil none. Macrospores small, chalk-white, with high ridges and strongly honeycombed all over. Central Africa. *I. amazonica* A. Br. ms. Rootstock 3-lobed. Leaves 10–20, 2–3 inches long, $\frac{1}{4}$–$\frac{1}{3}$ lin. diam. at the middle, firm in texture, furnished with stomata and accessory bast-bundles, with a membranous border, about $\frac{1}{2}$ inch long, decurrent from the dilated base. Sporange small, white, globose, much spotted; veil rudimentary. Macrospores middle-sized, chalk-white, closely strongly tubercled. *I. cubana* Engelm. ms. Rootstock 3-lobed. Leaves 10–50, $\frac{1}{2}$–1 foot long, $\frac{1}{2}$ lin. diam. at the middle, opaque, moderately firm in texture, furnished with stomata and accessory bast-bundles, the membranous base suddenly dilated. Sporange small, oblong, unspotted; veil very narrow. Macrospores small, strongly tubercled. Microspores papillose. Cuba.

### Muscineæ.

**Structure of Dumortiera.***—With the exception of the Riclleæ, *Dumortiera* is described as the only genus of true Marchantiaceæ which wants the usual layer of air-chambers with the stomata, as well as the ventral scales. H. Leitgeb has subjected the genus to close examination with a view of confirming or otherwise this statement, the species specially examined being *D. irrigua* and *hirsuta*.

His conclusion is that at least these two species exhibit a complete uniformity with the normal Marchantiaceæ, at all events in an early stage, in the possession of a layer of air-chambers and of stomata, in the formation of the ventral scales, and in possessing both kinds of rhizoids, the unthickened and the conical. The only difference consists in the fact that the cover to the air-chambers, which represents the epidermis, and the ventral scales, perish at an early period. The walls of the chambers and the layer of cells which form their floor then alone remain, and the latter presents the appearance of being the true epidermis. Whether this is the case with all undoubted species of *Dumortiera* remains yet to be determined.

A specimen sent from New Zealand as *Dumortiera dilatata* was

* 'Flora,' lxiii. (1880) p. 307.

determined by the author to be a male specimen of a *Monoclea*, and this is also the case with specimens in herbaria bearing this name. Professor Leitgeb is in doubt whether *D. dilatata* has any existence at all, and whether all specimens so named do not belong to a hitherto undescribed species of *Monoclea*, which should be called *M. dilatata;* belonging therefore not to the Marchantiaceæ, but to the Jungermanniaceæ.

**Formation of the Sporogonium of Archidium.***—This genus of mosses is of special interest as presenting a point of contact between the Phascaceæ and Bryineæ, and at the same time exhibiting points of resemblance to the Hepaticæ. Professor Leitgeb has made the structure and mode of formation of the sporogonium a subject of special study.

The author regards the sporogonium of all Musci (including Sphagnaceæ) as consisting, in its earliest stage of development, of an inner mass of cells, the endothecium, which is distinctly separated from a peripheral mass, the amphithecium. According to the mode in which the spores are developed, he distinguishes the following types:—

A. Spores formed from the amphithecium.

1. *Sphagnaceæ* type. The endothecium produces only the columella, which however does not penetrate the spore-forming layer, but is covered by it.

B. Spores formed from the endothecium. The sporogonium always grows by means of a two-edged apical cell.

2. *Archidium* type. Spore-forming and sterile cells are intermingled in the endothecium; the spore-sac is separated from the wall of the capsule by a bell-shaped cavity.
3. *Andreæaceæ* type. The endothecium is differentiated into a spore-forming layer and the columella which does not penetrate the former. The innermost layer of the amphithecium becomes the spore-sac, which however is not separated from the wall of the capsule by any cavity.
4. *Bryineæ* type. The endothecium is differentiated as in No. 3; but the columella penetrates the spore-sac, which is separated from the wall of the capsule by a cylindrical cavity.

The following are the most noteworthy points in connection with the development of the spores and sporogonium of *Archidium:*—

1. In the first stages of the development of the sporogonium until the differentiation of the amphithecium and endothecium, *Archidium* agrees with the other Phascaceæ.

2. The same is the case also with regard to the formation of the outer spore-sac; but this, as in the Andreæaceæ, covers the inner tissue as a closed bell-shaped layer, and is separated from the wall of the capsule by a cavity.

* 'SB. k.k. Akad. Wiss. (Wien),' lxxx. (1880) p. 447.

3. The inner tissue does not originally exhibit any differentiation into spore-forming layer and columella. A few cells, undefined both in position and number, which varies from one to seven, become the mother-cells of the spores, in each of which four spores are formed tetrahedrally.

4. The cells of the spore-space which remain sterile, as well as those of the inner layer of the spore-sac, and of the two inner layers of the wall of the capsule, are subsequently again absorbed, while the outer layer of the spore-sac remains, almost until the spores are ripe, in the upper part, but altered so as to be hardly recognizable, and appearing as a homogeneous membrane.

5. In respect to the processes which are carried on in the spore-space—the differentiation into spore-mother-cells, which are irregularly interspersed, and cells which remain sterile—*Archidium* resembles the Hepaticæ more closely than the Bryineæ. The resemblance is especially close to the Riclleæ, with which it agrees also in the structure of the calyptra.

**Transition of Female to Male Organ in a Moss.***—This phenomenon, probably never before observed in cryptogams, is recorded by Lindberg in *Hypnum erythrorhizon*. A barren female plant showed some altogether abnormal perichætia; these proved to consist on one side of forms resembling the ordinary female organs, on the other, of organs approximating to the structure of antheridia. These latter were almost cylindrical from the base upwards, instead of having the pear-shaped form of the archegonium; their interior was found to contain a substance resembling dried spermatozooids; no female central cell could be distinguished among them. The upper edge, however, is circular, and presents a level plane with a central invagination, as in normal antheridia. The same plant bore regular and typical archegonia of a narrow flask-like shape with a long neck; the upper end has a projecting rim with more or less distinct lips; the central cells are also present, as usual. The discovery of the hermaphrodite species, *H. reflexum*, described by Blytt, bears out the correctness of the present observation; it is possibly merely a similar specimen of *H. erythrorhizon*, wrongly identified.

## Fungi.

**New Genera of Fungi.**†—Sig. Saccardo has compiled a conspectus of the fungi found in Italy, belonging to the class known as "Fungi imperfecti," and regarded by the majority of mycologists as early forms of the Ascomycetes and other higher fungi.

He classifies them first under three divisions, the Sphæropsideæ, Melanconieæ, and Hyphomyceteæ. The Sphæropsideæ are further divided into three sections, the Sphæroideæ, Dimidiato-septatæ, and Subcupulatæ. Within each section the form and colour of the spores are the characters used for further classification. In the Melanco-

* 'Oefv. K. Vet. Akad. Förh.' (Stockholm) 1879, No. 5, p. 75 (1 plate).

† 'Michelia,' 1880, p. 1. See 'Bot. Centralbl.,' i. (1880) p. 515.

niceæ there is no further division into sections. In the Hyphomyceteæ, the largest of the three divisions, there are four sections, the Mucedineæ, Dematieæ, Didymosporæ, and Tubercularieæ, with numerous subdivisions. 214 genera are described, among them the following new to science:—

*Dendrophoma* Sacc. Perithecia calva *Phomæ*, sed basidia ramulosa vel denticulata pleiospora. *Dothiorella* Sacc. Stroma basilare; perithecia botryose aggregata; sporæ oblongæ. *Septaglœum* Sacc. Conidia oblonga, 2-pluriseptata, hyalina (est *Glœosporium* conidiis pluriseptatis). *Ovularia* Sacc. Biophila; hyphæ subsimplices, erectæ, apicem versus conidia globosa vel ovoidea gerentes. *Pyricularia* Sacc. Hyphæ biogenæ subsimplices; conidia obclavato-pyriformia, 2-pluriseptata, solitarie acrogena. *Cercosporella* Sacc. Candida, biogena; hyphæ simplices vel ramulosæ; conidia vermicularia, pluriseptata (est *Cercospora mucedinea*). *Dactylaria* Sacc. Saprophila; hyphæ fertiles erectæ, simplices, apice capitulum conidiorum gerentes; conidia fusoidea vel clavulata, 2-pluriseptata. *Heterobotrys* Sacc. Conidia catenulata vel simul glomerulata, sphæroidea, in eodem mycelio majora et minora, fuliginea et hyalina; hyphæ a conidiis vix distinctæ. *Ceratophorum* Sacc. Conidia phyllogena fusoidea vel cylindracea, sursum incurvata et pallidiora. *Stigmina* Sacc. Conidia ovoidea vel oblonga, 2-pluriseptata, in acervulos aggregata, phyllogena, basidiis brevibus fulta. *Gonatobotryum* Sacc. Hyphæ fuscæ, simplices, erectæ, hinc inde noduloso-inflatæ, ibique denticulato-sporigeræ; conidia ovoidea. *Mesobotrys* Sacc. Hyphæ *Chætopsidis;* conidia ovoidea. *Harpographium* Sacc. Conidia falciformia, continua, hyalina. *Cosmariospora* Sacc. Conidia constricto-didyma, verruculosa, hyphis tenuissimis ramulosis varie inserta; sporodochium verruciforme, superficiale, botryoideo-lobatum. *Tuberculina* Sacc. Conidia in basidiis crassiusculis brevibus simplicibus vel parce ramulosis acrogena, globulosa; sporodochium plano-pulvinatum. *Heliscus* Sacc. Sporodochium applanatum; conidia cylindracea, apice clavi ad instar polygono-capitata, mediocria, basidiis parce divisis nixa. *Strumella* Sacc. Sporodochium verruciforme, ex hyphis varie ramosis conidiisque ex ovoideo polymorphis varie adnatis compositum.

**Mode of Escape of the Spores from the Asci in Ascomycetes.***—This point has been carefully investigated by W. Zopf, with the following results:—In *Sordaria* the asci project through the ostiolum of the perithecium, in consequence of elongating very considerably, and then first burst. In all the Ascomycetes in which the spores are forcibly ejected, they are connected together by various contrivances, sometimes by appendages, sometimes by a gelatinous envelope. These collections of spores are frequently attached to the apex of the ascus in various ways, a point of importance in their ejection. Heliotropism plays its part not only in the entire perithecium, but also in the separate asci. The Pyrenomycetes, which have no ostiolum, often exhibit contrivances for facilitating the opening of the

* 'SB. Ges. naturf. Freunde Berlin,' 1880, p. 29. See 'Bot. Centralbl.,' i. (1880) p. 323.

perithecium and the escape of the spores. In *Chætomium fimeti* there are at the base of the perithecium very hygroscopic hair-like appendages, which attach themselves to other objects, and by their elasticity burst the perithecium. In *Cephalotheca tabulata* n. sp. (possibly identical with *Eurotium pulcherrimum*), the wall of the perithecium consists of polyhedral shields, separated by a layer of a delicate tissue, which are easily forced apart by the pressure of the asci.

Fungus-parasites of the Aurantiaceæ.*—A. Cattaneo contributes a list, with descriptions, of no less than 34 species of fungus parasitic on the orange and its allies, including the following new species:—*Sclerotium Citri*, on rotten lemons; *Phoma Hesperidearum*, on living leaves; *Septoria Hesperidearum*, on leaves; *Glœosporium Hesperidearum*, on living leaves; *Hysterium Aurantii*, on dry wood of the orange; *Cryptovalsa Citri*, on roots which have lost their bark.

Fungi parasitic on Forest-trees.† — E. Rostrup publishes a memoir on the fungi parasitic on forest-trees in Denmark, excluding the Uredineæ, which have been previously treated of. The species specially described are *Agaricus melleus* and *ostreatus*, *Trametes radiciperda* and *Pini*, *Polyporus fomentarius*, *igniarius*, *conchatus*, *radiatus*, *sulphureus*, *suaveolens*, and *populinus*, *Thelephora laciniata*, *Stereum hirsutum*, *Corticeum sulphureum*, *Gymnoasci*, *Peziza Willkommi*, *Rhytisma*, *Lophodermium*, *Hypoderma*, *Ustulina*, *Nectria ditissima*, *Phyllachora*, *Cladosporium*, *Erysiphei*, *Phytophthora Fagi*, and *Schinzia Alni*.

*Agaricus melleus* is destructive not only to all Coniferæ, with the exception of the silver fir, but attacks and kills many other trees, especially the beech, hornbeam, alder, birch, poplar, willow, sycamore, and mountain ash. It is especially injurious to young pines of from five to ten years old. Among the other most destructive fungi are *Trametes radiciperda* and *Nectria ditissima*, while it is shown that several species of *Polyporus* are true parasites.

Witch-broom of the Cherry (Exoascus Wiesneri).‡—The peculiar deformity of the cherry, birch, &c., known as "Hexenbesen," or "witch-broom," is stated by De Bary, in his 'Morphologie u. Physiologie der Pilze,' not to be caused by parasitic fungi, but to be of unknown origin. E. Ráthay believes, on the contrary, that he has established that this disease is caused in the cherry by *Exoascus deformans Cerasi* Fckl., the mycelium of which persists in the malformation, branching out each year into the young shoots, and forming its hymenium in May on the under side of the leaves between the cuticle and the epidermal cells.

*Exoascus deformans Cerasi* has a well-developed mycelium, and 8-spored asci, and is therefore well placed in this genus. It differs specifically from the *E. deformans Persicæ* Fckl. of the peach, for

* 'Archivio laborat. Botan. Crittogam. di Pavia,' iii. (1879). See 'Bot. Centralbl.,' i. (1880) p. 450.

† 'Tidsskr. for Skovbrug' (Copenhagen). iv. (1880) p. 1.

‡ 'Oesterr. Bot. Zeitschr.,' xxx. (1880) p. 225.

which reason Ráthay proposes to confer on it the specific name *Exoascus Wiesneri* Ráthay. Besides *Prunus avium*, it occurs also on *P. Cerasus* and *Chamœcerasus*, causing similar broom-like malformations.

**New Vegetable Structures from Coal and Anthracite.**—In a separate communication, Herr Paul F. Reinsch gives, with two plates, an account of some of the results of his long researches into the flora of past epochs. The deposits mentioned are, he believes, largely composed of microscopic vegetable structures of extreme simplicity. In the older Devonian strata (of Illinois) he has found bodies which have some resemblance to the *Myxomycetes*, and these he has found again in other parts of North America, and he has been able to trace them to Upper Jurassic formations. Taking altogether the numerous localities in which he has found them, he is certain that the coal is in no way made up of the remains of the higher plants, which are in comparatively small proportion as compared with vegetable forms of the very lowest grade.

The most remarkable body which he has met with is a strongly polarizing substance, which is either found in regular isolated spheres and polygonal bodies, or in mass in the clefts of crystals. Where most constant in size and structure, they are 0·5–2·5 mm. high, formed of a dark grey, hard, horny substance, of a rather higher specific gravity than ordinary coal, and made of spheres 0·13–0·24 mm. in diameter. The spheres consist of a radially arranged, more or less brown, granular substance, with scarcely any indication of a concentric striation. They hardly resemble, morphologically, any plants already known to us, and it will be necessary to form for them a special division.

After giving a detailed account of their structure, the author says that, it being certain that we have not here to do with "mineral bodies," it follows that either: (1) they are crystals formed from the dissolution of some organic compound, comparable to the "sphærocrystals" deposited from alcoholic or aqueous solutions of chenopodin; or (2) they are organized bodies, which are either independent plants (comparable to the unicellular Fungi and Algæ of the present period), or they are parts of some other plant. The author is distinctly in favour of the facts speaking to one or other of the two latter views. He forms, therefore, two genera, which he characterizes thus: *Blastophragmium*, with the body formed of three different substances:—

*a*. A fibrillar, multiramified, filamentar substance.

*b*. Pellucid substance intermixed with granules 0·0008 mm. in diameter, and with pellucid fibrillæ arranged in longitudinal rows.

*c*. Semipellucid polarizing substance formed of centrogranular granules, arranged radially, and forming regular spheres; the system of the tubules simple, the "tubules" arranged radially, closely compressed, and all of the same length.

The second genus, *Asterophragmium*, is composed of only two substances; one is granular and non-pellucid, and the other semipellucid, and possessed of polarizing properties.

**Classification of Bacteriaceæ.***—In a general review of our state of knowledge of the Schizomycetes, Dr. Luerssen arranges the genera of Bacteriaceæ as follows:—

I. Cells not united into filaments, separating immediately after division, or in couples, free or united into colonies (*Zooglœa*) by a gelatinous substance.
  A. Cells dividing in one direction only.
    α. Cells globular: *Micrococcus.*
    β. Cells elliptical or shortly cylindrical: *Bacterium.*
  B. Cells dividing regularly in three directions, and thus forming cubical families, having the form of packets strung crosswise, and consisting of 4, 8, 16, or more cells: *Sarcina.*

II. Cells united into cylindrical filaments.
  A. Filaments straight, imperfectly segmented.
    α. Filaments very fine and short, forming rods: *Bacillus.*
    β. Filaments very fine and very long: *Leptothrix.*
    γ. Filaments thick and long: *Beggiatoa.*
  B. Filaments wavy or spiral.
    α. Filaments short and stiff.
      *a.* Filaments slightly wavy, often forming woolly flocks: *Vibrio.*
      *b.* Filaments spiral, stiff, moving only forwards or backwards: *Spirillum.*
    β. Filaments long, flexible, with rapid undulations, spiral through their whole length, and endowed with great mobility: *Spirochæte.*

A diagnosis follows of each species, with an account of what is known of its structure and habits, and of its physiological rôle.

**Atmospheric Bacteria.**†—Continuing the observations contained in a previous paper,‡ which did not deal with *Bacteria*, M. Miquel has succeeded in counting the spores of bacteria, and while confirming M. Pasteur's observations that they are always present in the air, shows that their number is subject to incessant variations.

Very small in winter, the number increases in spring, is very high in summer and autumn, then sinks rapidly when frost sets in. This law also applies to spores of fungi; but while the spores of moulds are abundant in wet periods, the number of aerial bacteria then becomes very small, and it only rises again in drought when the spores of moulds become rare. Thus, to the *maxima* of moulds correspond the *minima* of bacteria, and reciprocally.

In summer and autumn, at Paris, 1000 germs of bacteria are frequently found in a cubic metre of air. In winter the number not uncommonly descends to four and five, and on some days the "dust" from 200 litres of air proves incapable of causing infection of the

* 'Rev. Internat. Sci.,' iii. (1880) p. 212.
† 'Comptes Rendus,' xci. (1880) p. 64.
‡ See this Journal, i. (1878) p. 192.

most alterable liquors. In the interior of houses, in the absence of mechanical movements raising dust from the surface of objects, the air is fertilizing only in a volume of 30 to 50 litres. In M. Miquel's laboratory, the dust of 5 litres usually serves to effect the alteration of neutral bouillon. In the Paris sewers, infection of the same liquor is produced by particles in 1 litre of air.

These results differ considerably, it is pointed out, from those published by Tyndall, who says that a few cubic centimetres of air will, in most cases, produce infection in the most diverse infusions.

M. Miquel compared the number of deaths from contagious and epidemic diseases in Paris with the number of bacteria in the air during the period from December 1879 to June 1880, and established that *each recrudescence of aerial bacteria was followed at about eight days' interval by an increase of the deaths in question.* Unwilling to say positively that this is more than a mere coincidence, he projects further observations regarding it.

M. Miquel further finds (contrary to some authors) that the water-vapour which rises from the ground, from rivers, and from masses in full putrefaction, is always micrographically pure; that gases from buried matter in course of decomposition are always exempt from bacteria: and that even impure air sent through putrefied meat, far from being charged with microbia, is entirely purified, provided only the putrid filter be in a state of moisture comparable to that of the earth at ·3 metre from the surface of the ground.

**Modification of the Properties of Bacillus anthracis by Cultivation.***—In the course of some experimental investigations into the pathology of anthrax at the Brown Institution, made during the past twelve months, two series of phenomena have been the subject of study, and in each some results have been attained which Professor W. S. Greenfield (in a "preliminary note") believes to be novel, and of considerable practical importance if verified by other observers.

The practical purpose of these investigations was to ascertain (1) by what means the virus of splenic fever may be so modified as to be capable of inoculation without fatal result, and (2) whether a modified attack, produced by inoculation, exerts any protective influence against a future inoculation with unmodified virus.

The conclusions arrived at by these experiments were as follows:—

1. That anthrax may be artificially communicated to bovine animals by inoculation with the blood or spleen of the guinea-pig which has died of the disease artificially induced, and that the same result may be attained by inoculation with the *Bacillus anthracis* cultivated from the fluids of a rodent; the disease thus induced being severe, but rarely fatal to previously healthy bovine animals, a result previously attained by Dr. Burdon-Sanderson independently.

2. In all the cases thus inoculated, the animals appeared to have acquired either a considerable degree of protection or entire immunity from the results of subsequent inoculation, although much larger doses of the virus were employed.

* 'Proc. Roy. Soc.,' xxx. (1880) p. 557.

In the course of these experiments the author employed on several occasions *Bacillus anthracis* artificially cultivated in successive generations in aqueous humour, and finding that the results appeared to vary considerably with the stage of the cultivation, those furthest removed from the original parent-source being more frequently inactive, he was led to make a series of observations of which he now communicates the results. They may be stated as follows:—

That when *Bacillus anthracis* is artificially grown in successive generations in a nutrient fluid (aqueous humour), it maintains its morbific properties through a certain number of generations, but each successive generation becomes less virulent than its predecessor, requiring both a longer time and a larger quantity to exert its morbific action; and after continuous diminution of virulence, at a certain stage in the successive cultivations, the *Bacillus*, though maintaining all its morphological characters and its power of growth, becomes completely innocuous even to the most susceptible class of animals.

It may be added that the modified virus produces forms of modified disease which differ widely from ordinary splenic fever, both in the distribution of the *Bacilli* and in the nature of the symptoms and pathological appearances.

In regard to the general method employed in the determination of the gradual diminution of virulence by successive artificial cultivations, the cultivating fluid was aqueous humour in closed tubes half filled, and the animals inoculated chiefly mice. The cultivations were continued to the nineteenth generation, each successive generation presenting identical morphological characters at the various stages of its growth, and showing no diminution in the capacity for growth nor marked variation in the time and temperature relations of its germination. In no case were any symptoms or a fatal result produced by inoculation with a later generation than the twelfth, beyond that stage, a large quantity of actively germinating rods and spores produced no result whatever. The diminution of virulence was very marked at the eighth generation, both as regards the proportion of animals affected, and the rapidity of action with an equal dose.

The author defers at present dwelling upon any conclusions to be drawn from the experiments pending further investigations.

**Bacterium fœtidum: an Organism associated with profuse Sweating from the Soles of the Feet.***—Dr. George Thin refers to the fact of the feet of certain individuals being characterized by a peculiar powerful and fœtid odour, which is really connected with the moisture (an admixture of sweat with serous exudation from the blood) that soaks the soles of the stockings and the inside of the boots.

When a small portion of the sole of the wet stocking was teased out in water, the drop of water was found to be swarming with micrococci. A second generation of the organism, which the author calls *Bacterium fœtidum*, was obtained by placing a small piece of the wet

* 'Proc. Roy. Soc.,' xxx. (1880) p. 473.

stocking in a test-glass, charged with pure vitreous humour. This and succeeding generations were cultivated at a temperature which varied between 94° and 98° Fahr. The successive generations were obtained by inoculating pure vitreous humour, with requisite precautions. In twenty-four hours the surface of the vitreous humour was always found covered with a delicate scum, which in forty-eight hours was compact and tolerably resistant.

In the scum of one day's growth and in the fluid below it organisms were found as cocci, single and in pairs, in transition stages towards rod formation, as single and jointed rods, and as elongated single rods. Many of the rods were actively motile. The compact scum of two days' growth was sufficiently resistant to be removed in an unbroken sheet. When disturbed by the needle it fell to the bottom of the glass. It was found to contain all the forms found in the twenty-four hours' growth, and in addition long unbroken rods in transition stages towards the formation of chains of spores. Spores were also found lying beside the empty and partially empty sheaths from which they had been discharged. Groups of single spores and pairs, identical in size and appearance with those which had come to maturity in the sheaths, were found mixed up with rods in all phases of development.

The first stage in the development of the organism is the formation of a pair from one coccus.

The next stage is that in which the whole body is wedge-shaped, the round brightly-refractive coccus being found in the thick end of the wedge. Another phase, which is probably the successor of the preceding one, is the appearance of a canoe-shaped figure with the bright coccus in the centre.

Other appearances connected with the early stage of development, and probably following the wedge- and canoe-shaped figures, show the organism developed into a staff-shaped body, containing two elements of very different refractive power. The coccus element is still distinct and is brightly refractive, the other element is very slightly refractive and is seen as a dull shade, with however perfectly distinct outlines. The coccus may be at one end of the rod, two cocci may be in the centre close together with a prolongation of protoplasm on either side, or a central rod of protoplasm may have a coccus at either end.

In the next stage we have the formation of the rods characteristic of *Bacteria*. The distinction between the coccus and the protoplasm becomes lost, although transitions are found in which faint differences of refraction still betray the two elements. The formation of rods of ordinary size, of long rods with unbroken protoplasm, of rods with segmented protoplasm, and of rods filled with spores or cocci, progresses identically with the similar formation in *Bacillus anthracis*.

The *Bacterium* grows in turnip infusion less actively than in vitreous humour.

Dr. Thin states that an antiseptic treatment by which the bacteria were killed in the stockings and inner surface of the soles of the boots completely destroyed the fœtor.

**Alcoholic Fermentation.***—In regard to the transformation of alcoholic liquids into vinegar, Pasteur, as is well known, holds that the formation of vinegar is a physiological phenomenon caused by vegetation of *Mycoderma aceti*, while Liebig sees in it merely a chemical action of oxygen on alcohol. Recent observations by Herr Wurm, at the Breslau Institute of Plant-Physiology, are regarded as putting the former view beyond a doubt, and Herr Wurm has succeeded in effecting the industrial manufacture of vinegar in accordance with Pasteur's view. The conditions are a sowing of pure *bacteria*, a uniform temperature of 30° C., and a well-regulated addition of alcohol. The process goes on in large covered wooden receptacles (with side-holes for air), into which are put 200 litres of a mixture of vinegar, water, and alcohol, along with some mineral salts (phosphates of potash, lime, magnesia, and ammonia). Full particulars have been published in Dingler's 'Polytechnisches Journal.' The manufacture is said to be considerably more rapid than that by the old method, and distinctly economical.

**Clastoderma.†**—A. Blytt describes a new genus and species of Myxomycetes.

Sporangia discreta, calce destituta, stipitata. Columella brevissima aut subnulla. Capillitium e columella ortum, ramis solidis, lilacinis, demum lutescentibus, repetite bifurcatis, ramulis non anastomosantibus. Sporangii maturi membrana in fragmenta membranacea subhyalina inter se libera et distantia divisa. Fragmenta irregulariter rotundata, oblonga aut subpolygona, ramulis ultimis capillitii singulis vel 2–5 affixa. Sporæ lilacinæ.

*Clastoderma Debaryianum* n. sp. Sporangia sphæroidea, diam. $\frac{1}{4}$–$\frac{1}{5}$ mm. Stipes fusco-flavescens, erectus, 1·3–1·4 mm. longus, e basi latiori versus apicem sensim attenuatus (basi 210–215 $\mu$, apice ca. 8 $\mu$ latus), ad basin columellæ annulo membranaceo angustissimo cinctus. Columella subnulla, rotundata aut brevissima (30 $\mu$ longa), apice dilatato rotundata. Sporæ sphæroideæ læves, diam. 9 5–11 $\mu$. Fragmentorum membranaceorum diametrus 10–15 $\mu$, in fragmentis oblongis diametrus longior usque ad 30 $\mu$ longa.

Hab. in Polyporo emortuo, faciei inferiori gregarie insidens, in silva abiegna prope Farnebo Christianiæ (Norvegiæ) mense Septembri 1879 (A. Blytt).

## Lichenes.

**Monograph of Arthonia.‡**—A very valuable monograph of all the Scandinavian species of *Arthonia*, referring also to species found elsewhere, is compiled by S. Almquist. The diagnosis of the genus is nearly identical with that of Nylander and Leighton:—Excipulum nullum vel rarissime ambiens; epithecium peridium non formans; asci pyriformes; paraphyses indistinctæ; reactio amyli semper distincta, vulgo intensa.

* See 'Engl. Mech.,' xxxi. (1880) p. 492.

† 'Bot. Zeit.,' xxxviii. (1880) p. 343.

‡ 'Kongl. Svenska Vetensk-Akad.,' xvii. (1880) p. 1. See 'Bot. Centralbl.,' i. (1880) p. 355.

In accordance with Schwendener's well-known theory, the author regards the genus as belonging, like other lichens, to the Ascomycetes. Were the gonidia to be regarded as special organs, the following improbable results would ensue: (1) Very nearly related species, like *A. granitophila* and *neglectula*, and even different forms of the same species, as *A. mediella*, would have different organs of assimilation, differing greatly from one another, and without any transitional forms. (2) Very nearly related species, as *A. spectabilis* and *subastroidea*, and even different forms of the same species, like *A. radiata*, would differ in some of them possessing, while others were altogether without, organs of assimilation. (3) Both the hyphæ and the gonidia and cortical cells would present no difference, whether *Arthonia* was autonomous, or whether it derived its nutriment from the cortical cells. (4) The structure of the thallus would be the same, whether *Arthonia* had gonidia, or whether it made use of the gonidia of other lichens.

The absence of gonidia is no sufficient reason for excluding a plant from the group of lichens. The gonidia of the same or of allied species are either Palmellaceæ or Chroolepidæ; the gonidia of two species are often intermixed. The gonidia not unfrequently owe their origin to the thallus of other lichens; for example, those of *A. phæobæa* to *Verrucaria ceutocarpa*. Soredia occur in some species. In *A. fusispora* there are apothecia-like structures, which the author is inclined to regard as soredia.

The genus is divided into seven sections: viz. Coniangium, Conioloma, Pacnolepia, Trachylia, Euarthonia, Nævia, and Lecideopsis, the last of which is new, and includes the new species, *A. amylospora*, *vagans*, *intecta*, and *oxyspora*.

### Algæ.

**Algal Vegetation of the Siberian Sea-coast.***—In spite of his conviction expressed in 1876 that no new forms would be added to the known Algæ of the Siberian part of the Arctic Ocean, F. R. Kjellmann is able to identify from Baron Maydell's description three species from Tschaun Bay as belonging to the genera *Alaria* and *Laminaria;* they were observed in the Russian Geographical Society's Expedition of 1869.

The results obtained in Professor Nordenskiöld's expedition show that an algal flora appears at various points at a distance from the coast, as well as in the sublittoral regions; only two of the former localities show a poor list of species, and here these are confined to *Lithothamnion polymorphum*, *Phyllophora interrupta*, and *Lithoderma fatiscens*. Two shore stations furnished only two species, which were an *Enteromorpha* and a *Urospora*. Fucaceæ do not occur at all in the littoral region, and only one, *Fucus evanescens*, was met with in the eastern part of the Arctic Ocean, and has a wide though scanty distribution in the western part. The richest localities were the so-called North Cape (lat. 68° 55′ N., long. 179° 25′ W.), and the mouth of the Koljuschin Gulf. The most

* 'Oefv. K. Vet. Akad. Förh.' (Stockholm), xxxvi. (1880) p. 23.

common species are *Polysiphonia arctica*, *Rhodomela tenuissima*, a form of *R. subfusca*, *Sarcophyllis arctica*, *Phyllophora interrupta*, *Sphacelaria arctica*, and *Phlœospora tortilis*.

In all, *Florideæ* are represented by 12 species, *Fucoideæ* by 16, *Chlorophyllophyceæ* by 6, *Phycochromophyceæ* by 1, in the material examined by Kjellmann.

**Algæ of the Utah Salt Lake.***—Dr. A. S. Packard, jun., has examined some of the "seaweeds" of the Great Salt Lake which are probably almost the only source of food for the brine-shrimp, as they are diffused through the water in nearly equal abundance with the crustaceans themselves, and do not appear to grow attached to any objects in the lake or on the shore. The most common form is a rounded mass which lives suspended in the water.

Professor W. G. Farlow, of Harvard University, soaked out and examined the dried material, which he found to consist largely of grains of sand and remains of small animals, mixed with which were three species of Algæ. The most abundant was one forming irregular gelatinous masses, sometimes attaining a diameter of half an inch. The colour, apparently much faded in drying, was brownish with a tinge of bluish green,† and he considered it to be a new species of *Polycystis*—*P. Packardii*. Its distinguishing characters are the oblong shape of its cells, which are smaller than in any of the marine species of the genus, and the firmness and lobulated form of the gelatinous substance in which they are embedded.

There was also a species of *Ulva* (using the word in the extended sense adopted by Le Jolis) in fragments, so that no very accurate idea of its habit could be formed. The microscopic characters, however, showed that it was, with scarcely any doubt, *Ulva marginata* Ag., found on the coast of Europe. The specimens agreed very well with those from the French coast, considered by Le Jolis to be the species described by Agardh.

The third Alga was much less abundant than the others, and was in poor condition for comparison with herbarium specimens. It was a *Rhizoclonium*, coming very near to *R. salinum* Ktz. (*R. riparium* Harv.), a common marine species of America, and also found in Europe near salt springs. The Salt Lake plant has smaller cells and approaches *R. Kochianum*, a species also marine and found in saline regions.

Professor Farlow adds that "as a rule, the Algæ found in saline regions belong to species found in brackish waters on the coast. One might expect to find a large variety of Ulveæ and Conferveæ in Salt Lake, and it would be of interest to see how closely these inland forms approximate to the littoral forms of the eastern and western coasts."

**Antherozoids of Hildebrandtia rivularis.‡**—Sig. Borzi describes the antheridia of this alga, found abundantly in May on smooth slate-

* 'Am. Nat.,' xiii. (1879) p. 701.
† The colour in life is an olive green.
‡ 'Rivista scientifica,' i. (1880). See 'Bot. Centralbl.,' i. (1880) p. 481.

stones in streams at Vallombrosa, near Florence. Looked at from the surface, the antheridia-bearing thallus appears to be covered by a number of roundish or irregular, somewhat elevated, pale dots, consisting of a number of densely-crowded antheridia. They are elongated cylindrical cells, developed vertically from the apex of the superficial cells of the thallus, twenty or more from a single cell. Their contents are at first homogeneous, but are subsequently differentiated into seven or more nearly globular antherozoids, placed in a row one above another, which are set free by the rupture of the mother-cell.

**New Vaucheria.*** — M. Woronin describes, under the name *V. de Baryana*, a new *Vaucheria* collected by him in streams near Montreux, on the Lake of Geneva, but also earlier by De Bary and Peyritsch near Halle.

The thallus scarcely differs in any respect from that of other species of the genus. The filaments are more or less branched, usually from 0·03 to 0·04 mm. in diameter; the chlorophyll is fine-grained, and of a bright green colour. Notwithstanding this, the tufts of this alga have a very pale green or even a grey tint, owing to their being copiously encrusted, when old, with calcium carbonate, to such an extent that on the death of the filament the encrustation frequently remains behind in the form of a connected tube. This is not an encrustation from without, but a secretion from the substance of the *Vaucheria* itself.

From the thallus spring the fertile branches, erect lateral shoots, 0·2–0·3 mm. in length, containing a great quantity of oil and chlorophyll. The extremity of each of these branches develops gradually into an antheridium. While this is taking place, a lateral protuberance is formed on the upper half of the branch, which becomes a stalked oogonium. The development of the two organs advances *pari passu*, so that ultimately their orifices stand on the same level. The terminal antheridium and stalked oogonium determine *V. de Baryana* to belong to Walz's section, *Vaucheriæ racemosæ*, but it differs from the other species in the form of the antheridium. Instead of being curved, with the form of a horn or hook, it has two blunt lateral projections, which give it the appearance of the handle of a crutch; the projections are, however, sometimes three or four in number. The form of the antheridium bears the nearest resemblance to those in *V. piloboloides* and *sphærospora*; but these species belong to a different section. The orifice from which the antherozoids escape is always at the end of these protuberances. The oogonia are spherical and stalked.

The process of fertilization takes place in the same way as in other species of the genus. The mature oospore is usually quite spherical, and fills up the whole of the oogonium; occasionally it is beaked.

Normally there is a single superior antheridium, and a stalked oogonium; occasionally two antheridia accompany a single oogonium,

* 'Bot. Zeit.,' xxxviii. (1880) p. 425.

or two oogonia a single antheridium, or even two or three oogonia two antheridia. The production of zoospores was not observed by Woronin. He considers the new species to be most nearly allied to *V. geminata*, and believes that, like that species, it may assume a *Gongrosira*-condition, and hence occur also in an amœboid state.

**Parasitic Nostoc.***—Several Algæ belonging to the group of Nostochineæ enter and live in the tissues of various terrestrial or aquatic plants, and an additional instance of this has just been observed by M. L. Marchand, which he reports on account of its singularity.

He collected on the edge of a ditch near Montmorency, some small flask-shaped bodies, of a blackish-green colour, ovoid, cylindrical or like commas, from ·1 to 1·5 mm. in height, which were fixed to the ground by branched radicular filaments. They vegetated on the damp soil intermixed with numerous specimens of *Pottia* (*Gymnostomum truncatulum*), *Anthoceras lævis*, *Riccia glauca*, *Jungermannia tenuis*, &c., and in some places covered the ground. They are reproduced each year, disappearing in winter to reappear in the spring.

These seemed at first to be young individuals of *Botrydium granulatum;* but when examined under the Microscope they presented an entirely unusual character. Instead of being lined with a layer of granular chlorophyll, the interior of the ampulla was lined with a network of moniliform filaments presenting all the characters of chaplets of *Nostoc* or *Anabæna*.

The author discusses the probable nature of these singular bodies, which, though further examination is yet required, he is inclined to believe are due to one of the Nostochineæ (*Anabæna* or *Nostoc*), which, having penetrated into the radicular filaments of a moss or Hepatica, and there developing, cause a considerable local swelling of the neighbouring wall.

**Movement of the Cell-contents of Closterium lunula.**†—Mr. A. W. Wills points out that at each end of the fronds of certain Desmidieæ there is a clear oval or spherical space, within which are seen a number of minute particles in more or less active motion, at any rate during some periods of the life of the plant. This is especially the case in the genus *Closterium*, and conspicuously so in the largest species, *Closterium lunula*.

In this plant there is also, as has been often observed, a certain motion of the colourless granular liquid cell-contents which form a thin film between the deep-green endochrome mass and the cell-wall of the frond. This motion has been described as a circulation, but the term is incorrect. The actual character of the movement is one of ebb and flow, alternately towards and from the ends, and, in favourable specimens, careful examination under a $\frac{1}{4}$ or $\frac{1}{6}$ objective shows that it takes place in delicate longitudinal lines or bands, and that in *different* lines the flow may be actually in opposite directions at the same time, while in *any one* line the direction of flow is usually

* 'Bull. Soc. Bot. France,' xxvi. (1879) p. 336.
† 'Midl. Nat.,' iii. (1880) p. 187.

reversed every few seconds, a moment of rest or of confused movement of the particles among one another preceding the reversal of the direction.

The cause of this peculiar ebb and flow has not, he believes, been previously recorded.

The clear spaces at the ends of the fronds of the *Closterium* are really contractile vesicles, and careful observation under the above powers shows that they are undergoing incessant though slight change of form. The contraction of any part of the surface of the vesicle is followed by an immediate rush of the surrounding fluid to fill the vacuum thus formed, and the direction of the currents, where the transparent spaces allow them to be observed, may be clearly connected with the corresponding contraction of one or other part of the vesicle. In stating their flow to be in lines or bands, it is merely intended to describe the general appearance of the action. The whole space between the endochrome and the cell-wall is, doubtless, filled with the fluid; but the transverse section of the former would probably present a fluted or corrugated form, corresponding to its longitudinal disposition in belts of denser matter; and the flow of the surrounding fluid may probably be determined by the channels formed by this fluted structure.

These movements may be found to have their parallel in the smaller species of *Closterium*, and in other genera of Desmidieæ in which there is a terminal vesicle.

It is to be noted that the flow of cell-contents, while it is actuated by the contractile motions of the vesicle, is a phenomenon wholly distinct from the swarming of the larger particles within it, the functions of which are, Mr. Wills fears, still hidden in entire obscurity.

Endochrome of Diatomaceæ.* — A writer in the 'English Mechanic,' referring to M. Petit's paper, of which we gave a translation at p. 680, says, "The English student of the chromatology of plants will not fail to be surprised, on reading M. Petit's article, to find no reference to the valuable work done by Mr. Sorby in this department of scientific research, and we can only come to the conclusion that M. Petit is, as so many of his countrymen appear to be, extremely ignorant of the present position of vegetable and animal chromatology in England. This is very much to be regretted, as there is no doubt that had M. Petit been familiar with the valuable paper read by Mr. Sorby before the Royal Society in 1873, and published in the 'Proceedings' of the Royal Society in that year,† his conclusions would have been much modified, and the ground covered in his research not only greatly extended, but more minutely examined. There is no doubt, for instance, that M. Petit would have found reason to believe that his phycoxanthine is identical with that of Kraus, and, as Mr. Sorby has shown, is really a 'mixture of two or three distinct colouring matters, which can easily be separated and do occur separately in other plants.' The true phycoxanthine

* 'Engl. Mech.,' xxxi. (1880) p. 573. † No. 146, vol. xxi.

of Sorby *gradually fades* on the addition of hydrochloric acid and turpentine. . . . . The writer has no doubt (taking his stand almost entirely upon the charts in M. Petit's paper) that the so-called phycoxanthine, in the condition in which M. Petit examines it, consists of the yellow xanthophyll of Sorby, with a slight admixture of chlorofucine, true fucoxanthine, and lichnoxanthine, with contamination by imperfect separation of the chlorophyll, which is itself compound, and a very little of true phycoxanthine. But whilst we are compelled to regret that M. Petit's work is incomplete, we express our thanks to him for having opened up a new field of inquiry for our diatom friends."

---

## MICROSCOPY, &c.

**Microscopical Analysis of Water.*** — M. Certes observes that recourse must be had to the Microscope in order to discover the nature of the minute organisms of water, whether badly infested by them or not. The great difficulty of discovering these bodies in pure waters is best overcome by the use of osmic acid, which also at once kills and preserves them.

An experiment which shows the efficacy of his method is to place 30 c.c. of distilled water in each of two tubes, and in one of them to agitate a glass tube which has been dipped in water infested with microscopic organisms; to the contents of both tubes equal amounts of osmic acid are added. In examining the water with the Microscope while the one sample shows nothing organized, in the one into which the rod was dipped even the few dead Infusoria are to be found.

In a drinking water, containing but little organic matter, a solution of osmic acid of the strength of 1·5 per 100 is used, and 1 c.c. of this is added to 30 or 40 c.c. of the water; after some minutes as much more distilled water is added as the vessel will contain (in order to check the action of the acid). The length of time after this at which the mixture may be examined varies from a few hours in the case of a highly impure liquid to from twenty-four to twenty-eight for a very pure one; at the end of the time it must be decanted with great care, so as to leave the precipitate in from 1 to 2 c.c. of liquid.

The use of staining materials has some advantages; among the best of these materials, M. Certes considers are Ranvier's picrocarmine, methyl green, eosin, hæmatoxylin. Paris violet has the recommendation of deeply staining minute and transparent objects; it should be very dilute; it then colours cellulose blue, amyloid matters red, and gives a bluish-violet tint to cilia, flagella, and the protoplasm of Infusoria. Whatever staining matter is used, it is advisable to mix some dilute glycerine with it previously to use, care being taken not to allow the organisms to be shrivelled by too rapid action of the glycerine of the mixture; they are thus kept transparent, and may be preserved well in the glycerine.

* 'Comptes Rendus,' xc. (1880) p. 1435.

It is probable that the method may be well employed in examining the tissues and liquids of animals for parasites. The author has thus treated the Anurous Batrachia.

On this subject it may be also noted that Professor Huxley has recently thrown some doubt on the conclusions arrived at by chemists in determining the wholesomeness of water. Organic matter may be either of animal or vegetable origin, the former being dangerous, and the latter much less so, if not altogether innocuous. To distinguish between the two kinds is therefore all-important, but unfortunately it is impossible directly to do this, as both animals and plants yield albuminoid matters, which, chemically speaking, are practically identical in composition. None of the processes in use by chemists can be relied upon as giving any indication of the nature of the organic matter, i. e. whether it is dangerous or not, and yet it is the almost invariable custom to judge of a water by the quantity of organic matter it contains, no matter what its origin, and a variation of two or three times a given amount is held to make the difference between a good and bad water.

It was to this point that Professor Huxley especially addressed himself at a meeting of the Chemical Society, and gave it as his opinion, speaking as a biologist, "that a water may be as pure as can be as regards chemical analysis, and yet as regards the human body be as deadly as prussic acid, and, on the other hand, may be chemically gross, and yet do no harm to any one." "I am aware," he said, "that chemists may consider this as a terrible conclusion, but it is true, and if the public are guided by percentages alone, they may often be led astray. The real value of a determination of the quantity of organic impurity in a water is that by it a very shrewd notion can be obtained as to what has had access to that water."

Mr. C. Ekin, commenting * upon these statements, says that since chemical analysis fails entirely to distinguish between innocuous and deadly kinds of matter, it may be thought a work of supererogation to have recourse to it at all. What, however, analysis fails to do directly it can to a large extent do indirectly. Organic matter in solution in water is more or less prone to oxidation, the highly putrescible matter of sewage being most so, and that derived from vegetation being much less so. Hence it follows that one would expect to find the oxidized nitrogen compounds in a greater excess in the one case than in the other, and that is what we do find. Almost invariably in all waters of acknowledged wholesomeness the quantity of nitrates never exceeds a certain small amount, whereas in polluted well and spring waters the oxidized nitrogen compounds, with other accompaniments of sewage, are to be found in excess. By means, then, of these oxidized nitrogen compounds we get collateral evidence throwing light on the nature and probable source of the contamination, of which a mere percentage estimation of organic matter would fail to give the slightest indication.

The mistake has been hitherto that the discussion has been narrowed by looking at the question almost entirely from a chemist's

* See 'Nature,' xxii. (1880) p. 222.

point of view. It is, however, to the biologist that we must look chiefly for the future elucidation of the subject, and he has a field of the widest range, embracing much untrodden ground, for his investigations.

**Brownian Movement.**—Similar motions to those shown under the Microscope by small particles in liquids have been attributed to dust-particles in air, and accounted for by the shock of molecules with the particles.

In a paper treating fully of the movements of very minute bodies,* Herr Nägeli calculates (from data of the mechanical theory of gases as to the weight and number, and collisions of molecules) the velocity of the smallest fungus-particles in the air that can be perceived with the best instrument, supposing a nitrogen or oxygen molecule to drive against them. It is, at the most, as much as the velocity of the hour-hand of a watch, since these fungi are 300 million times heavier than a nitrogen or oxygen molecule. The ordinary motes would move 50 million times slower than the hour-hand of a watch. Numbers of the same magnitude are obtained for movements of small particles in liquids. In both cases a summation of the shocks of different molecules is not admissible, as the movements are equally distributed in all directions.

Nägeli therefore disputes the dancing motion of solar dust-particles, and attributes the Brownian molecular motion to forces active between the surface molecules of the liquid and the small particles; but he does not say how he conceives of this action.†

**Examining very soft Rocks.**—The following process of preparing sections of very soft and friable rocks is communicated ‡ by Mr. J. A. Phillips to Mr. F. Rutley. The chip, which may be to some extent hardened by saturation in a mixture of balsam and benzol until thoroughly impregnated with it, and afterwards dried, should be gently ground or filed down until a smooth, even surface is procured; this surface must then be attached to a piece of glass slide cut about an inch square, and this again fixed in a similar manner by old balsam to a thicker piece of glass if needful, so that it can be conveniently held whilst the grinding is carried on. When it is reduced to such a degree of tenuity that it will bear no more grinding, even with the finest materials, such as jewellers' rouge, and when the removal of the section from the glass to which it is attached would almost inevitably result in the destruction of the preparation, the lower piece of glass should be warmed and separated from the upper piece which bears the section, and this, with its attached section, should be again cemented by the under side of the glass to an ordinary glass slip, covered in the usual way, and if the edges of the section, or its glass, be disfigured by grinding, a ring or square margin of Brunswick black or asphalt may be painted over the unsightly part.

* 'SB. K. Bay. Akad. Wiss.,' 1879, p. 389.
† See 'Nature,' xxi. (1880) p. 350.
‡ F. Rutley's 'Study of Rocks' (8vo. London. 1879), p. 70.

Mr. Rutley himself says:*—In the case of very soft rocks, such as tuffs, clays, &c., useful information may sometimes be acquired by washing to pieces fragments of the rock; in this way a fine mud and often numerous minute crystals and organisms may be procured. The best apparatus for effecting this gradual washing is a conical glass about 9 or 10 inches high, across the mouth of which a cross-bar of metal or wood is fixed. A little hole drilled in the centre of the bar receives the tube of a small thistle-headed glass funnel. Roughly broken fragments of the rock should be placed in the bottom of the conical glass, and the apparatus set beneath a tap, from which a stream of water is continually allowed to run into the mouth of the funnel, the overflow trickling down the sides of the glass, which should consequently be placed in a sink. In this manner a constant current is kept up, and the fragments at the bottom of the glass are continually turned over, agitated, rubbed against one another, and gradually disintegrated. This action should be kept up, often for many days, until a considerable amount of disintegrated matter has accumulated. Samples should then be taken out by means of a pipette and examined under the Microscope.

When the observer wishes to mount either such materials or fine scaly, powdery, or minutely crystallized minerals, the best method is to spread a little of the substance on a glass slide, moisten the powder with a drop of turpentine, and then add a drop of Canada balsam, and cover in the usual manner. If the attempt be made to mount such substances directly in balsam, without the intervention of turpentine or some kindred medium, air-bubbles are almost certain to be included in the preparation.

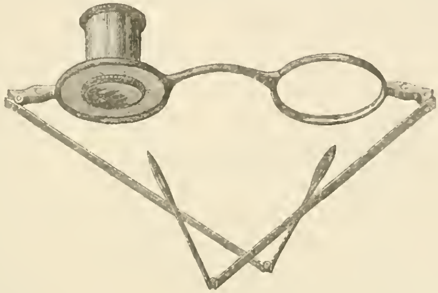
**Lenses for Petrographical Work.**—Mr. Melville Attwood, in a paper read before the San Francisco Microscopical Society, quotes the following passage from Mr. Frank Rutley's book on 'The Study of Rocks'†: "There is, however, a disadvantage attending the use of lenses when they are applied to the examination of rocks. This lies in the difficulty experienced by the observer when he attempts to examine the streak of minerals under the lens, especially when the minerals occur in very minute crystals or patches, as it is scarcely possible to hold a specimen, with a lens over it in focus, in one hand, and to work with a knife in the other. Laying the specimen on a table, and using a lens in one hand and a knife in the other, is a most unsatisfactory process; while the use of a lens fixed on an adjusting stand is scarcely better. To obviate this difficulty, the author has devised a small lens with a clip, which can be worn on the nose like an eye-glass, and both hands are then at liberty—the one to hold the specimen firmly, the other to use the knife or graver. This clip-lens is moreover better than a watchmaker's eye-glass, because it entails no muscular effort to keep it in place. It is better to have the lens mounted in a horn than in a metal rim as it is less heavy and consequently less liable to be accidentally shifted or displaced by the inclination of the head."

* F. Rutley's 'Study of Rocks' (8vo, London, 1879), p. 73.

† Ibid., p. 44.

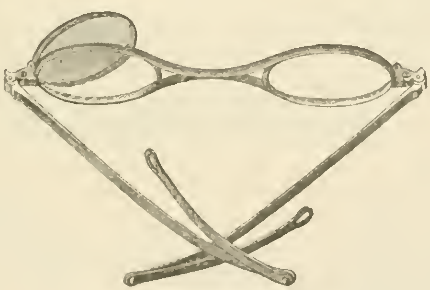
Mr. Attwood adds that instead of a clip-lens he uses a watchmaker's eye-glass, fixed with a screw into a light pair of steel spectacle frames, which he thinks the botanist, also, will find a very useful arrangement. This suggestion was, however, anticipated by the late Robert Brown, whose set of spectacles were some years since (1874) presented to the Society by Dr. Gray. Fig. 75 shows

FIG. 75.



one of the spectacle frames fitted with two double-convex lenses in a short brass tube forming a doublet; one lens being broken, the focus cannot now be determined. Fig. 76 shows another arrangement which allows the magnifier to be turned aside when it is desired to

FIG. 76.



use the naked eye. Two other pairs of spectacles also accompanied the preceding, with lenses of about 3 inch and 4 inch focus, the lens in one unscrewing.

**Process for Microscopical Study of very minute Crystalline Grains.***—M. J. Thoulet imbeds the particles of mineral in a cement which, when set, he slices and polishes for microscopical examination. The mineral powder to be examined is mixed with ten times its volume of oxide of zinc, and enough silicate of soda (or preferably, of potash) is added to make a thick paste. This paste is then transferred to a mould, made by laying a thin ring of glass upon a sheet of paper.

* 'Bull. Soc. Min. France,' ii. (1880) p. 7.

In a few days the mass will have set hard, and can be removed from the mould, ground, and polished like a natural rock, as it possesses great tenacity. On examination under the Microscope, the sections of mineral that it contains are easily distinguished in the midst of the surrounding opaque material.

**Dr. Matthews's Machine for Cutting Hard Sections.**—In the previous volume * we gave a preliminary account of this machine, and now add the full description, with woodcuts, Fig. 77 being a plan view, and Fig. 78 a side elevation.

Fig. 77.

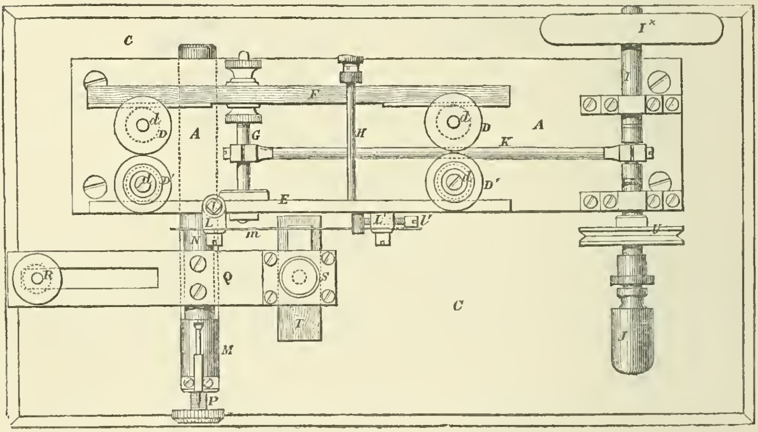
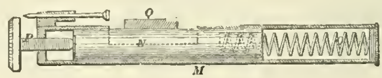


Fig. 79.



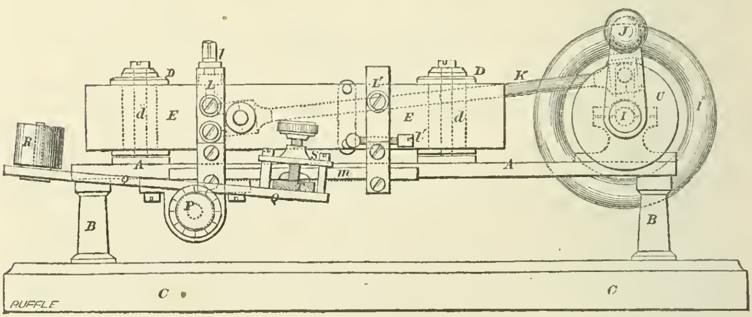



Fig. 78.

The metal stage-plate A is supported upon four pillars B B, and is mounted upon a base-board C. On the upper side of the stage A

* See this Journal, ii. (1879) p. 957.

are four vertical pivots *d*, upon which are fitted, so as to turn freely thereon, the four flanged rollers D D and D′ D′. In front of the rollers D is fitted a flat metal plate E, and at the back of the rollers D′ is similarly fitted a flat strip of wood F, the side of the strip bearing against the rollers being provided with a lining of india-rubber. The plate E and the strip F are secured together by means of the transverse tie bolt G and the clamp H, thus forming a kind of rectangular frame, capable of traversing freely to and fro on the rollers D and D′. At the end of the stage-plate A is mounted in suitable bearings a crank-shaft I, fitted with a flywheel I* and a winch-handle J. This crank is connected by the rod K to the bolt G of the rectangular frame E F. In front of the plate E are secured the metal bars L and L′. The bar L is slotted, and is secured by two screws, so as to be capable of adjustment vertically by means of the screw *l*. The bar L′ is pivoted to the plate by one screw, so as to admit of adjustment laterally by means of the screw *l′*. A fine saw web *m* is clamped by its ends to the two bars L L′.

The saw being clamped in its place, the requisite tension can be given to it by the screw *l′*, while, by means of the adjusting screw *l*, its parallelism can be secured. On turning the crank-shaft I by means of the winch-handle J, a reciprocating motion will be imparted to the frame E F and to the saw *m*.

For holding and imparting the requisite feed to the material to be cut, the following contrivance is adopted:—Beneath the stage-plate A is secured a tube M (shown detached in longitudinal section at Fig. 79). Sliding freely inside this tube is a solid cylinder N. This cylinder is pressed by a spiral spring O against a micrometer screw P. On the upper side of the cylinder N is secured by screws a lever arm Q. This lever arm carries at one end a counterpoise weight R, and is furnished at the other end with a clamp and binding screw S. The material to be cut—say a piece of bone—is fastened by any suitable cement (such as glue) to a slip of wood T, and this slip is clamped, as shown in the figure, to the end of the lever arm Q. By turning the micrometer screw P the cylinder N will be driven forward, carrying with it the lever arm Q and the piece of bone to be cut. The counterpoise R will now cause the piece of bone to bear upwards against the teeth of the saw, and a rapid reciprocating motion being imparted to this latter, as already explained, a thin slice will be cut off. This operation may be repeated until the whole of the material is cut up. The slices can then be removed from the wooden slip by soaking in a little warm water.

A grooved pulley U is provided on the crank-shaft in order that the machine may be driven by a flywheel and treadle if desired, and saws of different degrees of fineness may be employed to suit the various materials required to be cut.*

**Bleaching and Washing Sections.**†—Mr. S. Marsh, jun., suggests the direct action of free chlorine for bleaching vegetable tissues prior

* See 'Journ. Quek. Micr. Club,' vi. (1880) p. 83.
† Ibid., pp. 51-7.

to staining, avoiding the inconvenience of alcohol which is very slow in action and not always certain in result, and solutions of lime chloride and chlorinated soda (Labarraque's) which so disintegrate that many delicate tissues are utterly ruined. The former solution, in addition to its direct destructive influence, has a great tendency to permit of the formation on its surface of a scum of carbonate of lime; this, sinking into the fluid, settles itself upon the sections, so that if they escape absolute destruction they are in danger of becoming coated with a brittle film, which proves equally ruinous to them.

The apparatus employed for the purpose is shown in Fig. 80, and consists of two small wide-necked (1 oz.) bottles, with a bent glass (quill) tube passing through the centre of sound and accurately fitting corks which are made air-tight by shellac varnish. A notch is cut in the edge of the cork carrying the longer arm of the tube.

Fig. 80.

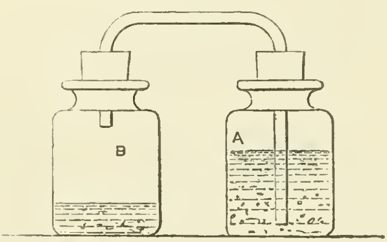
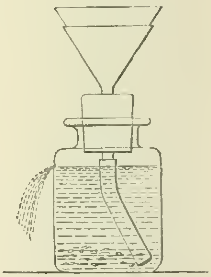



Fig. 81.



To use the apparatus, fill the bottle A three parts full with filtered rain-water, and to this transfer the sections to be bleached. Into bottle B put a sufficient quantity of crystals of chlorate of potash just to cover the bottom, and upon them pour a drachm or so of strong hydrochloric acid, and fit in the corks. Immediately the yellow vapour of chlorine (or, strictly speaking, of euchlorine) will be observed to fill the bottle B, whence it will pass along the connecting tube into the water contained in the bottle A, and effectually and safely bleach the sections. When the water becomes supersaturated, the excess of chlorine will accumulate in the bottle above the liquid, and find an exit through the notch in the cork. As to the time required for bleaching, this of course will vary in accordance with the nature of the sections operated upon. If the apparatus is set to work at night (out of doors, in a covered place), in the morning the bleaching is generally found to be complete; if not, further time may be allowed, without any danger to the sections being incurred.

Decoloration having been effected, the sections must be thoroughly washed to eliminate all trace of chlorine before employing any staining agent. The usual method of effecting this is to put the sections into a large basin full of water, and repeatedly to change the water. As this process is not only tedious, but exposes the sections to considerable risk of being contaminated with dust and other extraneous matter, Mr. Marsh employs a system of continuous washing (see Fig. 81). For this purpose a small wide-necked bottle, as for bleaching, is required, and into the side, half an inch or so below the bottom of the cork, a small hole about an eighth of an inch in diameter is drilled. A well-fitting cork must be pierced through the centre, so as to permit the stem of a small funnel to pass through it. By means of a small indiarubber tubing, the funnel stem is to be prolonged till it reaches the bottom of the bottle on the side *which is opposite to that containing the perforation.*

The bottle is then half filled with filtered water, and the sections put into it, and the cork carrying the funnel fitted in. After having placed a disk of filtering paper into the funnel, this is put beneath the water-tap, and a *gentle* stream allowed to trickle into it. The water will pass to the bottom of the bottle, gradually ascend, and then pass out at the hole in the side, by which means a constant change in the water in the bottle is brought about, and a system of continuous washing established. As in bleaching, so in washing, the apparatus may be left to do its work in the night. If the tap be set running in the evening, the washing will be found to have been most effectually accomplished by the morning.

**Wickersheimer's Preservative Liquid.*** — Herr Wickersheimer has been continually making experiments for improving this liquid,† and has become convinced that one and the same mixture is not suited for all objects; and he has therefore made four different kinds, for the application of which the following directions are given:—

No. 1 is for injecting whole corpses, including, when still practicable, the injection of separate parts; also for immersing preparations of muscle and nerve, and generally for preserving such preparations as easily become mouldy. The injection is effected by introducing the fluid by a syringe with a blunt tube into the carotid artery, or into any large blood-vessel in separate portions of corpses. For smaller bodies, 100 grammes of the liquid should be allowed for every kilo. in weight of the body, for larger ones 1 kilo. of liquid to 25 kilo. weight. For adult men and large animals, it is enough if ·500 to ·750 kilo. of liquid is used to every 25 kilo. weight.

No. 2 is for preserving and keeping flexible the ligaments of the skeleton; also for preserving Crustacea, beetles, &c., and for lung. The objects should lie in the liquid from two to six days, according to their size, and then be put by dry. Lung must be treated as follows, in order to retain its elasticity permanently. After having first forced out the blood, the lung is filled with the liquid by a funnel which is inserted in the windpipe until it is fully extended. Then, after the liquid has been allowed to drain away again through the windpipe, the lung is immediately treated several times with the liquid on the outside, and inflated; it is then advisable to rinse it once more in a mixture of one part of No. 1 and one part of glycerine, and put it in a

* 'Entomol. Nachr.,' vi. (1880) p. 129.

† See this Journal, *ante*, pp. 325 and 696.

wide glass with a close-fitting wooden lid, as this prevents the external surface of the lung becoming dry in case it is not inflated for a long time.

This is also adapted for permanently preserving plants, especially Algæ, without shrivelling or the chlorophyll changing. The experiments with plants, however, are not concluded, and Herr Wickersheimer hopes to make important advances.*

No. 3 is for microscopical objects. The process is the same as for glycerine. Those which are intended to be prepared later should be kept meantime in No. 2. Although with No. 3 excellent results have already been obtained, experiments are not concluded.

No. 4 is for preserving and hardening brains, and for preserving fishes and birds with their feathers.

The attention of anatomists, &c., is called to the fact that by injecting 2 to $2\frac{1}{2}$ kilo. of liquid No. 1 before dissecting, all possibility of blood-poisoning is prevented, although decomposition may have commenced. In those cases where it is not advisable to use No. 1 fluid, lest traces of arsenical poisoning should be effaced, another liquid can be employed which is quite free from poison, but, like No. 1, renders blood-poisoning in dissecting impossible.

It is not of course remarkable to find it stated that this liquid is "not new," and that it was invented by some one else twenty years ago.†

**Preserving the Colours of Tissues.‡**—It would undoubtedly be a great advantage if the specimens in our anatomical museums could be preserved with their original colours unaltered; but, unfortunately, hæmoglobin and most of the other pigments found in the tissues are dissolved out or destroyed, to a greater or less extent, by all the preservative fluids which are usually employed. If a piece of fresh tissue be placed in commercial alcohol it very soon becomes bleached, and the fluid becomes at the same time discoloured by solution of the colouring matters. Hæmoglobin is soluble in almost every known fluid, with the exception of absolute alcohol, which, however, causes great shrinkage of the soft parts, and is, moreover, too expensive to be very generally employed. Solutions of chloral hydrate have been used (and with great advantage in many cases); but here again, although the colouring matters are by this means retained unaltered, they are not thereby rendered insoluble, and hence they tend to pass out into the fluid, leaving the tissues partially decolorized. Other media have been tried, but all have a similar imperfection. By baking or otherwise heating the tissues, the pigments are so altered as to be rendered insoluble in alcohol; but, in addition to the tediousness of the process, the action of alcohol is then to turn them black in the course of time, and hence this method is but little employed, except with the object of demonstrating large extravasation and similar changes.

* See. this Journal, *ante*, p. 696.

† See Duncker's 'Zeitschr. Mikr. Fleischschau,' i. (1880) p. 100.

‡ 'Journ. Anat. and Physiol.,' xiv. (1880) p. 511.

It is a distinguishing characteristic of hæmoglobin that, although a crystalline body, it is not diffusible; and hence it occurred to Mr. H. Bendall that if specimens could be coated with a transparent membrane of a homogeneous nature, the colouring matters would be preserved *in situ*. For this purpose let a quantity of isinglass or transparent gelatine be taken and steeped in excess of cold water for twenty-four hours, and then, after draining off the supernatant fluid, be dissolved by heating over a water-bath. The specimen is then taken, and, after being carefully wiped to remove superfluous moisture, is either plunged in the liquid gelatine, or brushed thoroughly over therewith by means of a camel's-hair brush. After having received a uniform coat, the specimen is suspended in a cool and dry atmosphere for two or three hours, until the gelatine has had time not only to set, but to dry slightly on its external surface; it may then be suspended in a jar of alcohol, taking care that it be not allowed to rub against the sides of the jar for the first twenty-four hours. The alcohol, by its dehydrating power, rapidly removes the excess of water in the gelatine, and dries it up to a thin varnish-like, and (if suitable gelatine be employed) perfectly transparent coat, through which the pigments are unable to pass out. The alcohol employed should not be diluted, for if this be done the gelatine remains soft and easily comes off.

By this means the author has been enabled to preserve, in an almost unaltered condition, portions of muscle, liver, &c., for over four months; and not only so, but more delicate graduations of colour, such as are seen in an atheromatous aorta, for example, are well maintained.

It is as well to point out that this method is not suitable for such tissues as contain very much blood—e. g. the spleen—nor for cyanotic organs; for in such cases the blood pigment is carried to the free surface, and deposited beneath the gelatine in a layer which may be so dense as to give a darkened and discoloured appearance to the specimen. Nevertheless, for most tissues the method has hitherto yielded highly satisfactory results, and has the additional advantage that the alcohol does not become muddy or discoloured, and hence does not require to be frequently renewed.

**Staining-fluid for Amyloid Substance.***—Dr. Curschmann, of Hamburg, claims that methyl green has a peculiar affinity for amyloid substance, colouring it an intense violet. Surrounding tissues that have not undergone degeneration are stained green or bluish green. The contrast is striking; the smallest spot of amyloid disease can be readily discovered. Methyl green also colours hyaline casts ultramarine blue, so in a section of the kidney the healthy tissue would appear green, hyaline casts blue, and amyloid spots violet. A one per cent. aqueous solution is used, a few minutes' immersion being sufficient; a more uniform coloration is produced by using a more dilute solution and immersing the section for a longer time. Alcohol, turpentine, and oil of cloves quickly discharge the colour, hence

* 'Louisville Medical Herald,' ii. (1880) p. 123.

specimens cannot be mounted in balsam, but may be mounted in glycerine.

**Carbolic Acid for Mounting.**—The process described at p. 693 has been received with considerable favour by English microscopists, and we therefore print the following paper, also from Victoria,* which contains a full account of the process by Mr. J. R. Y. Goldstein, the Hon. Secretary of the Microscopal Society of Victoria.

" The mounting of objects in Canada balsam by means of turpentine has long since been a serious difficulty to students, and a nuisance even to practical hands. Turpentine evaporates so slowly that the hardening or baking and finishing of slides becomes a serious obstacle where time is concerned, while the previous preparation of objects saturated by water is exceedingly troublesome, and a general characteristic of messiness pervades the whole operation.

The members of this society have for some years adopted with advantage a method suggested by the President, Dr. Ralph, in 1874, by which the unpleasantness of mounting in balsam is avoided, and the time occupied considerably shortened. Now that the process has stood the test of years and has proved so decidedly beneficial, it is considered advisable to publish in the Journal of the Society a detailed description of it, in order that microscopists generally may know and use what may properly be called 'Ralph's Carbolic Process.'

When first calling attention to the subject Dr. Ralph suggested the use of glycerine as a means of withdrawing water from objects before using the acid, but experience has shown that this is not necessary, as by the use of heat carbolic acid will readily absorb, and eventually replace the water in any object saturated therewith.

The carbolic acid used should be the purest that can be obtained, and it will be as well to keep the greater portion as stock in a dark-blue glass-stoppered bottle, so as to prevent it being discoloured by exposure to light. From this can be transferred as required a small quantity to a working bottle of about two drachms capacity. If the acid is so pure as to be crystallized, melt what is in the smaller bottle and add a few drops of spirits of wine, which will easily mix with the acid if held for a few minutes over the spirit-lamp. The acid will then be less likely to crystallize and the small quantity of spirit used will not affect the process. Should there be any difficulty in procuring stock of perfectly clear acid, the ordinary coloured acid of the shops, if in crystals, may be used without fear. As will be noticed presently, we drive off all the carbolic acid used, replacing by clear balsam or dammar, therefore the coloured acid can do no harm. Perfectly clear acid soon becomes discoloured by exposure to light, and heat has a similar effect; when we boil objects in acid and allow them to remain for a few days, the acid will then have changed to a rich brown, but as this does not affect the object steeped therein, it need not trouble us further.

* 'Journ. Micr. Soc. Vict.,' i. (1880) p. 50.

The advantages claimed for this process are that objects need never be allowed to dry before mounting in balsam or dammar; that the operation from first to last is simple and cleanly; while compared with the old turpentine process, this is wonderfully rapid. A tiny insect may be caught alive, boiled, cleared, mounted in balsam, the slide finished off and put away in the cabinet, all within half an hour.

Objects saturated with water should be drained as well as possible, without allowing all the water to run off, as in that case air might be admitted, then transferred to a clean test-tube, covered with carbolic acid from the working bottle, and boiled for a few minutes over a spirit-lamp. Corked tightly, a test-tube full of objects in acid may be put aside for any length of time before mounting. When we desire to mount one of these objects we transfer it to a clean slide, put on a thin glass cover, and with the aid of a small pipette allow enough clean carbolic acid to run in to flood the object. Having examined under the Microscope, and arranged it to our liking, we warm the slide over a spirit-lamp, and place sufficient balsam or dammar on the slide close to the cover; liquefied by the heat either medium will at once run in and drive the acid out at the other side. This will be greatly facilitated by inclining the slide and holding a small piece of blotting paper under the thumb close to the lower edge of the thin cover. When all the acid has been drawn off, the slide is then placed on a hot-plate to harden, and afterwards finished in the usual manner by scraping off the superfluous balsam, wiping the slide carefully with a clean rag moistened with spirits of wine, and finished on the turntable by sealing the cover with a ring of Brunswick black or other varnish.

Another aid to the thorough displacement of the acid is to use the balsam in as thick and pasty a condition as possible. At the same time this is not essential to success, as thin balsam works very well. Benzine* should be used in preference to turpentine to liquefy balsam that has become too stiff. Newly purchased balsam is often very thin. In this case it is advisable to bake it in a cool oven for some days until it is hard enough to resist slight pressure, and then add about one-fourth part of benzine, placing the bottle in a hot-water bath, which will ensure perfect mixture. Balsam thus prepared will harden quickly, which it does not do if liquefied by turpentine. Turpentine may therefore be excluded from the Microscopist's laboratory.

When mounting, it is well to be provided with several pieces of blotting paper about an inch square. These should be used as above described to aid the substitution of one liquid for another, particularly when displacing watery carbolic acid by pure acid.

Vegetable tissues such as plant leaves, sections of wood, &c., after washing in water may be drained and transferred at once to the slide, covered by thin glass, flooded in carbolic acid, and then boiled over the spirit-lamp, adding fresh acid from time to time until the object is perfectly clear. Air bubbles may thus be boiled out, and the

* Some prefer chloroform, which will liquefy the balsam without heat, but we think the benzine much superior in subsequent operations.

object decolorized and rendered beautifully clear by the process. When cool add fresh acid and follow with balsam as above.

Insects whole, or their organs, and animal tissues generally may be treated in the same way, which seems to suit such organisms better than the old method. The action of the acid under heat is rapid * and can easily be stopped when required by simply blowing upon the cover.

In preparing Sertularians and Polyzoa, where the empty cells retain the air so pertinaciously, this annoyance may be overcome by boiling in water and allowing to cool, replacing the water by carbolic acid, when alternate boiling and cooling at intervals more or less lengthened will effectually dispose of air in the cells. Those who have opportunities of collecting on the sea-shore will find that just after storms many species will have been washed upon the beach, some possibly alive. Objects thus obtained, or by means of dredging, should at once be placed in small phials in a fluid consisting of spirits of wine and water in equal parts—sea-water will do. When these are taken home, they should be washed several times in fresh water to get rid of the salt, sorted, and transferred to a mixture of spirits of wine and fresh water in equal parts. They can thus be kept in good order for any length of time, or they may be mounted at once by the carbolic process.

Radulas or palates of molluscs should be boiled in strong liquor potassæ for a few minutes, well washed in three or four waters to remove all traces of the potash, and then, treated with the carbolic acid as above described, may be mounted very quickly.

To ensure clear mounts, the balsam should always be immediately preceded by perfectly clean acid, displacing with the aid of blotting paper the acid previously used. If this be neglected, and the acid first used should not be completely removed, a little cloudiness may result from the admixture of the balsam with the water in the acid. In this case the slide must be flooded in fresh acid to soften the balsam, heated, and the cloudy balsam drawn off by blotting paper, substituting fresh balsam."

Wax Cells.†—Mr. F. Barnard gives the following as a preferable process for making these cells:—Take a small piece of wax according to the size and depth of the cell required, place it in the middle of the glass slip, warm it thoroughly over a spirit lamp, then press it upon the slide perfectly flat and even with a smooth surface. This is easily done by means of what he calls a gauge made thus: on each end of a slip of glass, cement with balsam small pieces of paper, card, or glass of the thickness of the required cell, moisten the under side and press upon the warm wax till down as far as the end pieces will allow; by moving this gauge about a little, there will be a tolerably smooth and level cake of wax on the slide the thickness of the gauge.

* As some objects are injured by heat, they may be cleared by soaking in cold carbolic acid for a few days, or until cleared sufficiently.

† 'Journ. Micr. Soc. Vict.,' i. (1880) p. 53.

The centre can be turned out with a penknife or other convenient tool on a turntable. The cell can be cleaned with a rag moistened with benzine, or to avoid the difficulty of this the glass slip may be covered with a solution of gum tragacanth, to which a small quantity of sugar has been added, allowing it to dry before the application of the wax, when the marks of the knife left in turning out the cell can be removed by washing in water only. These cells would not, however, do for mounting in glycerine, water, &c., and the adhesion of the wax to the slide would be destroyed; but if the process is carried a little further and the slide with the cell on is soaked in water, the cell will be freed, and when washed and dried can be applied to another slide. By this use of gum any number of cells can be made and kept ready, like glass and vulcanite cells.

**Dry "Mounts" for the Microscope—Wax and Gutta-percha Cells.***—The following is by Professor Hamilton L. Smith (in the new American weekly periodical 'Science,' which is intended to be conducted on a similar plan to 'Nature').

"What shall we use to preserve dry mounts effectually? Many may think that nothing is easier; a cell of Brunswick black; a wax ring, or one of balsam; but the question is not thus easily to be disposed of. The writer has, within the last five years, mounted, or has had mounted under his supervision, some 15,000 slides of various microscopical objects, chiefly, however, foraminifera and diatoms; half of these were dry mounts.

Two things are important—the cell should be quickly and easily made, and the object when mounted in it should remain unchanged. There are very few cells as now made which will fulfil both these conditions, especially the latter. The deterioration of delicate dry mounts, and especially of test objects, sometimes within a few months after their preparation, but more or less certain in nearly every case, is well enough known.

All of the dry mounts of the Eulenstein series of diatoms, e. g., which I have seen, are spoiled; and my cabinet is full of such preparations. Even Möller's do not escape, though they are, upon the whole, the most durable. I have abundance of amateur works that no doubt looked very beautiful just as they issued from the hands of the enthusiastic preparers, which are now, alas! mere wrecks; and, worse than this, many choice and rare specimens, which I cannot replace, hopelessly ruined.

I believe that I was the first one to suggest the use of sheet wax for the bottoms of cells for foraminifera and other opaque objects, and of wax rings for diatoms and other transparent objects. The number of spoiled specimens, especially of diatoms and delicate transparent objects which I can now show, proves that this method of mounting is decidedly bad. I have lived to see the day when I shall be quite glad if the responsibility of suggesting such a nuisance as the wax ring can be transferred to some one else. For large opaque objects, like most of the foraminifera, seeds, pollens, &c., the object

* 'Science,' i. (1880) p. 26.

itself is not so much injured, but the covering glass will, sooner or later, become covered (inside the cell) on the under surface, with a dew-like deposit, which, when illuminated, will glisten almost like so many minute points of quicksilver, and though out of focus when the object is viewed, will show very disagreeably, like a thin gauze between; and with transparent objects these minute globules will not only dot the entire field as so many dark or light points, but the object itself will appear as though it had been wetted.

Not long ago a well-known optician showed to me a spoiled slide of *Podura*. The scales were very good and large—in fact, it was a slide which I had given to him, and it had been selected by myself in Beck's establishment in London as unexceptionably fine. This slide began slowly to show symptoms of 'sweating.' One scale after another appeared, as though moisture had, in some mysterious way, penetrated to the objects; it was not water, however, for when the cover, after much trouble, had been removed, and warmed sufficiently to evaporate anything like water, the scales still exhibited the same appearance, and, in fact, the heat required to get rid of this apparent moisture was so great that the scales were charred. When wax rings are used, this apparent wetting or 'sweating' occurs quickly, and more disagreeable than this, innumerable elongated specks, possibly crystalline, appear all over the under surface of the cover-glass. The same trouble occurs when any of the ordinary asphalt preparations are used, and the only cement which I have thus far found to be tolerably successful is shellac thoroughly incorporated with the finest carbon (diamond black), such as is used in the preparation of the best printing inks; the solvent being alcohol, these rings dry rapidly, and the cover is attached by heating. Even these rings cannot be trusted, unless thoroughly dry, and spontaneous drying is better than baking. I have had preparations spoiled after mounting on asphalt rings, which had been made for over a year, and which had been subjected for several hours to the heat of a steam-bath. With large, somewhat coarse objects, the defect is not so marked; but with delicate ones, and especially test objects, it is simply a nuisance. With care I think the shellac rings may answer pretty well. I have not tried the aniline coloured rings. The moisture (whatever it is), and the crystalline specks, appear to be derived from the vaporizable parts of the wax, or cement, given off under conditions where one would suppose such a thing impossible; it is, however, a fact; I have the proof of it, and I dare say hundreds of others have, too plainly evident.

There is another mode of making cells which promises well for permanence. My attention was first called to this method by Dr. Tulk, of London, who suggested for this purpose the thin gutta-percha tissue used by surgeons in the place of oiled silk. I have had special punches made, which cut neat rings from this tissue, and I have used these rings with the greatest satisfaction. I have no preparation of my own more than about two years old; these, so far, show no signs of change. Dr. Tulk informs me that he has them ten years old, and still good as when new. I have noticed that in some recent papers in the microscopical journals the writers, who with little experience have so lauded wax rings, speak of 'thin rubber' for rings; evidently they have seen somewhere the gutta-percha mount, and supposed it rubber—the latter will not answer, melted rubber will not become hard. One beauty of the gutta-percha ring is the very moderate heat required; it is thus available for many objects which might be injured by the greater heat necessary for the asphalt or shellac rings. As these rings, in the arrangement which I have spoken of, can be rapidly made, and as they can be kept for any length of time (shut away from the dust), they are at any moment ready as well as convenient for use. The preparation is first arranged, dried or burnt on the cover, the slide cleaned, a ring laid on the centre, and on this the cover is placed; the whole is now held together by the forceps, and *slightly* warmed, just sufficient to soften the gutta-percha; the forceps may now be laid aside, or used simply to press the cover home, warming the slide gently, also the cover; the perfect contact of the softened 'tissue' with the cover and slide is easily recognized, and with a little care this can be effected very quickly, and nothing further is necessary. A finishing ring of coloured cement makes a very neat mount, but it is not necessary."

Mr. F. Kitton, writing * on the above paper, says that he is unable to suggest a remedy.

The "damping-off" of dry mounts, particularly of diatoms, used to be (some twenty-five years ago) attributed to the imperfect washing of the diatoms: either the acid used in cleaning was not eliminated, or the water used for that purpose was impure; but preparations which showed no acid reaction, and which had been carefully washed with the purest distilled water obtainable, when dry mounted, still showed the presence of moisture. This was then accounted for (?) by the suggestion that the supposed moisture was really condensation from the asphalt ring supporting the cover; he therefore mounted some covers perfectly cleaned (by boiling in acid, washing in distilled water, and afterwards heating them over a Bunsen burner) on some hard asphalt rings; the slides were heated sufficient to cause the covers to adhere, and when cold the latter were concave, the interior of the cell being nearly exhausted of air. These mounts (about a dozen) were carefully finished, and then left upon the table for several months before examination. Some of them showed minute globules on the inner surface of the cover-glass, others minute radiating acicular crystals, and the remainder were perfectly clear.

This experiment being far from satisfactory, he tried "shellac" as follows: Perforating a hole about $\frac{1}{2}$ inch in diameter, in a piece of "thick" thin glass, he covered the edges with the lac, and cemented two thin covers to it, and with a similar result to the previous experiment. He also tried paper cells saturated with "shellac" dissolved in spirit, or soaked in paraffin wax, but in no case were they invariably successful. He has therefore come to the conclusion that the fault rests with the cover itself, and confirmatory to this opinion is the fact that the covers on balsam (hardened before attaching the cover) some-

* 'Engl. Mech.,' xxxi. (1880) p. 582.

times show like deposits. A similar "sweating" almost invariably occurs on our oculars, which has often been referred to an exudation from the "black" within the tube, but erroneously.

Mr. Kitton has in his possession a small box of thin covers, selected by the late William Smith, author of the 'Synopsis of British Diatomaceæ,' of which at least 30 per cent. exhibit traces of oxidation in the form of minute pits. Query—Would not these covers have shown the so-called "damping-off" if used?

**Covering Fluid Mounts.***—In mounting objects in fluid, one of the principal requirements is to fasten the cover of the cell securely, so as neither to permit leakage nor running-in of the cement. There are two methods described in most of the text-books, both of which have, according to Mr. W. M. Bale, disadvantages that impair their utility to a greater or less extent.

The first, which is recommended by Davies, is to paint the cell on its upper surface, and the cover on its under surface near the margin, with thin coats of gold size or other cement, and to press down the cover, forcing out the superfluous fluid in doing so, when the varnished surfaces of the cover and cell, not being affected by the fluid, will adhere together. It is a serious defect in this process that it will not permit of sliding the cover to one side after fixing it, if, as frequently happens, it should be necessary to readjust the position of an object which may appear on examination under the Microscope to require alteration. Moreover, thin pellicles of fluid frequently remain between the cover and the surface of the cell, preventing the perfect adhesion of the cement, and allowing the ingress of air. The other process, which is preferred by Dr. Carpenter, is to simply apply the cover upon a cell a little larger than itself, and when the outside is dry to paint it round the margin with varnish, giving several coats as they successively dry. This has the disadvantage of not holding the cover sufficiently firmly to the cell, and of being peculiarly liable to "running in."

These evils are to a great extent obviated in the following plan, which is especially adapted to cells of any thickness not greater than that of ordinary card or thin glass. An essential point consists in reversing Carpenter's rule, and using a cell *smaller* than the covering glass, so that when the cover is in position it projects beyond the cell for about one-sixteenth or one-twelfth of an inch on every side. The cells may be made of any suitable material—thin tissue paper will serve for minute objects, and common cardboard for those of considerable thickness. The cell may be attached to the slide, or simply placed in the position which it is to occupy, without being cemented. The objects are immersed in the fluid in the centre of the cell and the cover pressed gently down, forcing out the fluid which is in excess of the capacity of the cell, and after it is ascertained, by examination under the Microscope, that the object requires no readjustment, the fluid must be removed from the space between the cover and the slide *outside* the cell-wall. This is easily accomplished by simply allowing

* 'Journ. Micr. Soc. Vict.,' i. (1880) pp. 57–60.

the slide to stand till the superfluous fluid has evaporated, or, where the cell is thick enough, blotting-paper may be inserted under the margin of the cover to absorb it. If this plan be adopted, care must be taken, after the fluid is removed, to allow the slide to stand for a minute or two until the slide and the under surface of the cover margin are quite dry, otherwise the cement will not adhere. Two or three drops of thin balsam or gold size are then to be applied at different points of the edge of the cover, when it will run in by capillary attraction and fill the space outside the cell and beneath the cover. Directly this cavity is filled, any superfluous cement remaining on the slide must be removed, otherwise the running-in process will extend too far, and the cement will enter the cell. The slide may then be put aside to harden. It will often be found after a day or two, especially with cells of considerable thickness, that the cement will be so shrunk from evaporation as no longer to quite fill the space destined for it, when a little more may be applied at the edges till the space is refilled, care of course being taken to scrupulously remove the superfluous cement as soon as the requisite amount has run in. It occasionally happens that some of the fluid is forced out of the cell in process of drying, and occupies part of the space which should be filled only by the cement. This "running out" is no doubt caused by the shrinkage of the cement drawing the cover down more closely, and if the fluid extends only a very slight distance beyond the outer margin of the cell no injury is done, but if enough is expelled to make a passage nearly or quite through the cement wall, there will be a liability of leakage. The best safeguard against this mishap is to be cautious that the cement is not run in till the whole of the fluid has evaporated from outside the cell, or even till the thin film between the covering glass and the upper surface of the cell has commenced to dry. When this occurs, the cover will generally be drawn down as closely as is necessary, and the cement may be applied with reasonable security.

The result of this operation is to secure a double cell, the inner part consisting of the paper or whatever material may be used, and the outer of a solid wall of cement firmly uniting the slide and cover, and as wide as may be required. The author uses a cell about one-eighth of an inch less in diameter than the cover, giving a margin of $\frac{1}{16}$ all round. Care must be taken in finishing slides mounted in this manner, as he has found one commence to run in on the application of varnish, after being mounted some months, the fresh varnish having softened the original cement. This difficulty would probably be obviated by using a rapidly drying varnish, and only applying a thin layer at once, or by making a narrow circle of gum round the margin of the cover and allowing it to dry before using the finishing material; or by using paper covers, and thus dispensing with varnish entirely. There can be no doubt that slides mounted in this way will have almost the permanency of balsam mountings, so far as freedom from external influences can secure it.

A modification of the above process may be used with media which will not evaporate to dryness, such as glycerine and castor oil. In this case it will be advisable to place the object in the centre of the cell, in a quantity of the medium so small that on pressing down the cover the drop will not quite fill the cell, and consequently none will be forced out. The cement may then be run in under the margin, as above described. If the medium be thin and likely to spread over the floor of the cell before the cover can be applied, it will be better to suspend a small drop from the centre of the cover, and bring it down upon the object; and in any case the cover should be moistened with the medium before applying it.

The author adds in a note that he finds Tuckett advises the use of a cover larger than the cell, in order to prevent running in; but as he does not withdraw the fluid from the space round the cell, his method gains no advantage over the ordinary plan in security from leakage.

**Thickness of Cover-glasses.**—Dr. C. Reddots points out,* in answer to a complaint that cover-glasses are not accurately assorted as to thickness by the dealers, for which it was said "there seems no good reason," that the good reason is to be found in the extra cost that would be entailed by measuring, so that the matter is better left to each microscopist to do. Moreover, in these days of objectives with large working distance—homogeneous-immersion and others—there is no such necessity as there used formerly to be to hunt for very thin cover-glasses.

**Finishing Slides.**†—A writer in the 'American Monthly Microscopical Journal,' having used dammar dissolved in benzole as a mounting medium for some time past, finds that, when thoroughly dry, the gum becomes brittle, and a slight jar is apt to start the covering glass, and rapid destruction of the slide follows. He has found it necessary, therefore, to run a ring of some tough material around the covering glass to protect it, his efforts being directed to discovering a material that would give the necessary strength, that can be easily handled, so as to make a neat finish. The best results can be obtained by the use of a thick copal furniture-varnish—what is known as rubbing-varnish—using the thickest, finest varnish that can be procured, and putting enough dragon's blood in the bottle to give it colour, without destroying its transparency. It should be so thick that a small drop will not flow from the camel's-hair brush. The older it is the better.

The slide, having been cleaned of superfluous gum or balsam, should have a little shellac varnish run around in the angle formed by the covering glass and the slide to prevent the coloured varnish from running under the cover in the subsequent operations. When this is dry, which will be in a few minutes, the slide is mounted on the turntable, and a sufficiency of the varnish put round the edge of the covering glass, extending over the slide. The turntable is then put in rapid revolution, and with the point of a knife applied to the glass, first outside on the slide and afterwards inside on the covering

* 'Am. Mon. Micr. Journ.,' i. (1880) p. 123. † Ibid., pp. 122–3.

glass, a ring is spun, which may be made as narrow as is desired, and with its rounded top extending above the covering glass.

The slides are laid aside in a dry place for at least a week to harden, when the superfluous varnish can be cleaned off from the glass with a bit of soft linen rag and rottenstone and water, rubbing the whole mount gently with circular strokes. This removes the superfluous varnish from the glass to the edge of the ring, leaving it with a clean circular edge, and at the same time rubs down any inequalities which may exist in the ring itself. After this, wash the slide well in fresh water with a soft brush to remove all traces of the rottenstone, and gently dry it with a soft cambric handkerchief. When it is dry, a few circular strokes with dry cambric on the end of the finger, will give the ring a semi-polish, which leaves it with a very neat finish.

The whole slide is usually cleaned with the rottenstone and water, so that when it is dried and gently wiped, it is ready to receive the label. The whole process is quite expeditious, and the results are so satisfactory, in the permanence and finish of the slides, that the author is confident, if any one gives it a fair trial, it will supersede all other cements for a like purpose.

**Novel Form of Lens.***—Dr. Cusco, ophthalmic surgeon in one of the hospitals of Paris, has invented a lens of variable focus, in which the pressure of a column of water or other transparent liquid is made to alter the curvature of the flat faces of a cylindrical cell of brass closed with thin glass disks. The pressure can be regulated by a manometer gauge to any required degree within the limits of working. It is said that the lens gives a sharp, well-defined focus. It was constructed for Dr. Cusco by M. Laurent.

**Swift's Radial Traversing Substage Illuminator.**—Messrs. Swift have further developed the idea of a "swinging substage" by the apparatus shown in Figs. 82 and 83. The essential feature is the addition of a *second* sector with condenser at right angles to the first.

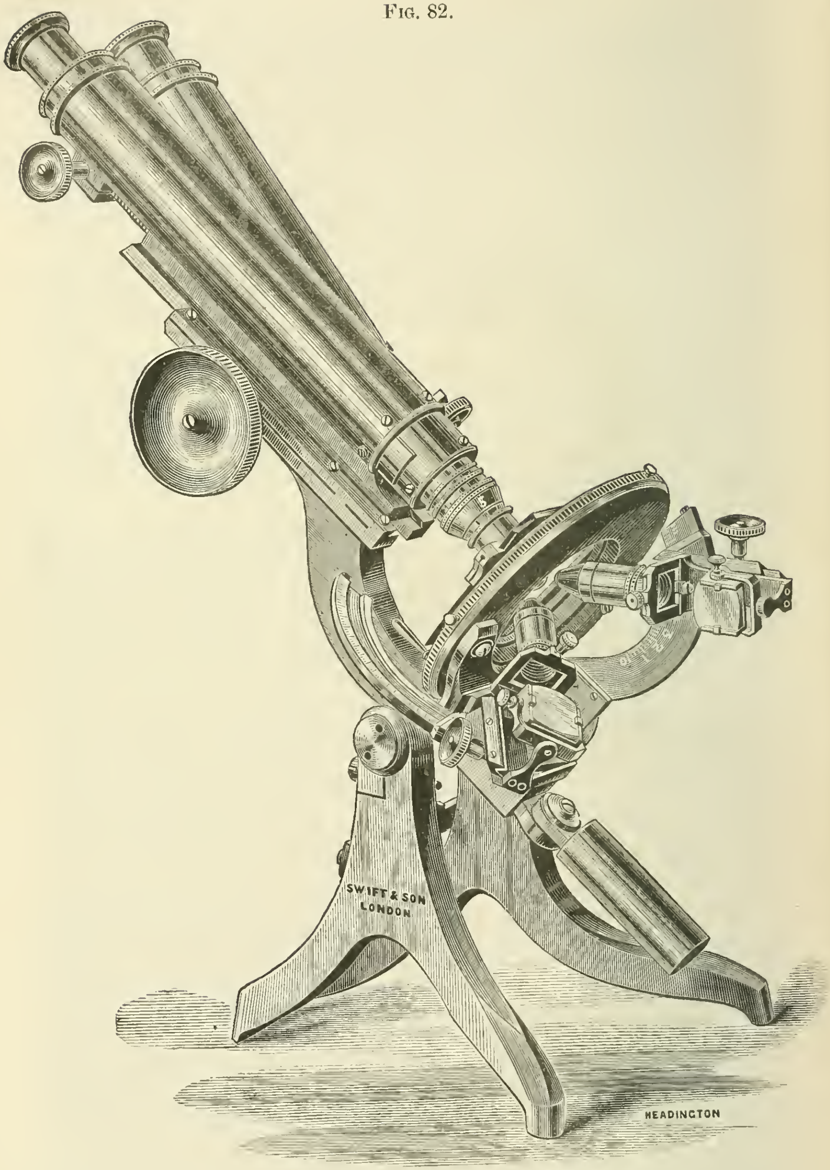
The following is their description of the apparatus (slightly abridged).

"This apparatus has been constructed for the purpose of increasing the resolving property of high-power objectives by causing still more oblique pencils to impinge on the object than can be obtained by any other method. The arrangement consists firstly of an arc-piece fixed below the stage radial to an imaginary line drawn through the axis of the objective, and in the same plane with the object. On this an achromatic condenser of special construction is made to travel, thus keeping the rays of light on the object during its entire traversing, these rays converging in a focus through the front lens in a highly concentrated form. The condenser is illuminated by a rectangular prism.

The next part of the contrivance consists of a second arc-piece placed at right angles to the former one; this also carries a similar achromatic condenser and illuminating prism, and moves radial to

* 'Nature,' xxii. (1880) p. 280.

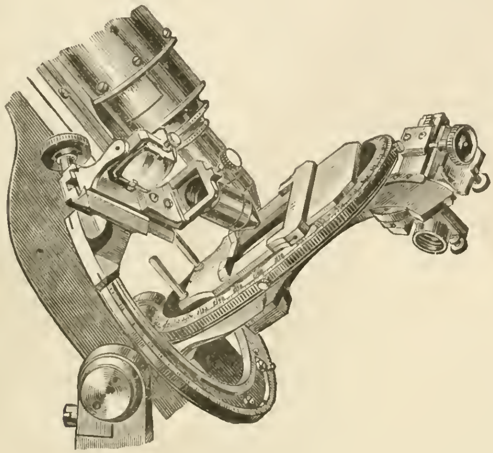
Fig. 82.




the same centre. Both these arc-pieces are so divided that each pencil of light can be projected at a similar angle, and previous results always recorded in the same way. Difficult test objects are readily revealed, especially such diatoms as have rectangular striæ or markings

With diatoms easily resolvable, and only requiring one pencil of light to show the markings, the second arc-piece with its illuminating apparatus can be turned away from the stage as shown in Fig. 83. The figure also shows how opaque objects may be illuminated, viz. by moving the condenser of the first arc-piece above the stage of the

Fig. 83.

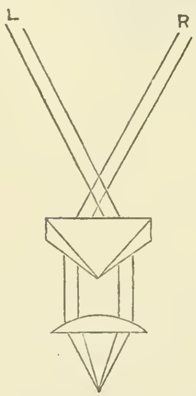


Microscope, when a pencil of light can be projected on to the object more perpendicularly than with the bull's-eye condenser, thus preventing shadows in coarse or deep objects which often produce distortion and false appearances. When the apparatus is used for opaque objects with a lower power than the 1-inch objective, the achromatic combination can be removed and the light directed from the prism, which can be made to give convergent rays sufficient for use with a 4-inch objective.

A great advantage is presented in this arrangement, viz. that a more oblique angle of light can be obtained with it than by other swinging stages, in consequence of the optical combination (with all its fittings included) being less than $\frac{1}{6}$ the diameter of the established size of substage used with the Zentmayer, for instance, thus enabling the apparatus to be moved further up to the under surface of the stage than if its mountings were larger. A still further improvement claimed for it is that the whole of the apparatus and its belongings can be easily detached from the Microscope, and an ordinary substage slid into the same fitting for the purpose of receiving polarizing apparatus, paraboloid, spot lens, &c. As its fitting is not adapted to or connected with the stage, the firmness and stability of this very important portion of the instrument are not thereby impaired."

**Holmes's "Isophotal" Binocular Microscope.**—The description of this Microscope should be added to the "Curiosities of Literature." The paper was recently presented to this Society, but withdrawn on our objection to print it *au serieux* and without alteration, having apparently met with a similar objection at the hands of the British Association authorities last year. Deviation is described as being "half as great when an isosceles prism is used," it being apparently supposed that an "isosceles" prism has an invariable angle instead of an infinite variety of angles. A prism is commended as giving "flatness of field." Reflecting prisms are described as causing more loss of light and more error than refracting ones, and notwithstanding a 5 per cent. *loss* of light by transmission, a net *gain* of 5 per cent. is vouched for as the result of the interposition between the objective and the eye-piece of the refracting "Isophotal" prism (!). The "distance of the prism from the objective in relation to the eye-piece" is held to have an effect on the angles of incidence and emergence. Wenham's prism is denounced as causing the "left-eye view to be darkened, definition impaired, field cylindrically distorted," and Stephenson's as having prisms with "twelve surfaces" (instead of six or eight), and as "practically useless from the line of sight being at right angles to the objective, and from torsion of the image." An achromatic prism is italicized as having only "*three surfaces*" (instead of four), and finally a right-angled prism is apparently in future to be known as a "Holmes prism."

Fig. 84.




The Isophotal prism as drawn by the inventor is shown in Fig. 84 (fac-simile).

The following is the inventor's description verbatim:*—

"In the course of experiments to produce a Microscope that might be used with both eyes, I have originated *three* constructions. The first of these acted by *total reflection*, the second by free transmission through *divided glasses*, and the third by an *achromatized prism*."

[The first † and second ‡ plans are then described.]

"With regard to my *third* and last plan of binocular Microscope, by means of an achromatic prism. The advantages I claim for it are (1) that it can be used as a monocular or as a binocular without change of body-tube; (2) that it gives two equally lighted fields in two equally inclined body-tubes; (3) that it gives stereoscopic effect with less loss of light or definition than any other construction with undivided glasses; and (4) from its evident adaptability to higher powers."

* 'Engl. Mech.,' xxxi. (1880) p. 464.
† 'Journ. Quek. Micr. Club,' i. (1869) p. 175.
‡ 'Mon. Micr. Journ.,' iii. (1870) p. 273.

[Here follows a description with diagrams of various binocular Microscopes, viz.:—Riddell's (1851), Nachet's (1852), Wenham's first (1853), Holmes's first (1858), Wenham's second (1860), Holmes's second (1869), Stephenson's (1870).]

"Here, then, we have six different systems employing prisms having from *four* to *twelve* surfaces to absorb light and impair definition. Division and angulation of the objective [Holmes's second plan] disposes of all these sources of error, and gives directness and value to an observation; but when that plan is considered inadmissible, the solution of the problem must rather be sought in the direction of a *refracting arrangement of few surfaces*, as less light is lost and less error introduced thus than by any number of reflecting prisms.

These considerations led to my third binocular, Fig. 84, wherein one achromatic prism of *three surfaces** of the form and in the position shown, divides the light from the objective and bends it into itself, until both its halves cross each other and diverge from opposite sides into two eye-pieces. I call this the *Isophotal* prism, and it gives the most correct stereoscopic effects to all objects viewed, without impairing illumination or definition.

The light lost by transmission is about 5 per cent., and the gain by observing with two eyes is about 10 per cent.; therefore, a more brilliant view is obtained in this manner than by a monocular, using the same glass and illuminator.

The two equally inclined bodies of the Microscope swing on a pivot, at their junction, to such extent as to bring one of them vertical, when the instrument becomes a monocular by merely withdrawing the prism. This motion was *first* devised by me for this Microscope.

In applying any refracting prism to a beam of light carrying an image, it is necessary to place the prism in such a position that it shall refract in its least degree—that is, cause the minimum deviation of the beam acted on; in all other positions the image of a circular spot of light will be elongated to an elliptical form.

In adapting a pair of prisms to bend the image pencils from the halves of an objective across each other into opposite eyes (Fig. 84), the violence is greater than if they were to be bent only into adjacent eyes. It therefore becomes important to construct the prisms of such a form as to give the least refraction possible for a given angle of glass; otherwise, the resulting images being elongated in one direction, a distorted view would be produced.

This error is entirely eliminated by attention to two considerations. Firstly, the prism must receive its beam at an angular and not at a perpendicular incidence; secondly, the distance of the prism from the objective in relation to the eye-piece must be such as to make the angles of incidence and emergence equal to each other—no other form or position being admissible without distortion. I claim to be the first to have recorded this action in connection with this subject, and to have based the construction of an instrument on the deduction.

* This should of course be *four* surfaces, which is equivalent to *eight* in all, the same as the Stephenson binocular when the reflecting plate is used.

The achromatized prism for stereoscopic effects can take but three forms. For simplicity's sake, I will only deal with one half of the prism, the other half being symmetrical.

If a right-angled prism (Fig. 85) receive the rays at a perpendicular incidence, the whole of the refraction takes place at the inclined second surface, and the distortion is the greatest possible.

If an isosceles prism (Fig. 86) be used, the deviation is half as great, but still so considerable as to preclude its use.

But if my form of prism (Figs. 84 and 87) receive the incident beam on its inclined surface, the angles are more nearly equal than in any other form in any other position, and perfect equality may be obtained by modifying the relative distances between objective, prism, and eye-piece.

These conditions at once indicate the dimensions of the prism. When in position it must be large enough to admit all the rays from the objective at the distance seen to give no distortion of a known object; and here we have distinctness and flatness of field also.

Such is the Isophotal prism, giving its name to the Microscope. In the course of experiments, I have made the prisms of the lightest and densest glass, of the longest and shortest diverging power, as large as a shilling, and again so small as to slide into a $\frac{1}{4}$-inch objective; and have arrived at what I believe to be the best form for practical use."

Fig. 85.

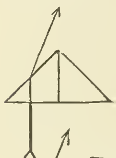
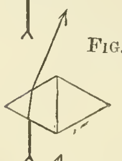


Fig. 86.



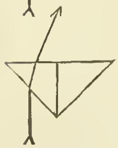


Fig. 87.

It need hardly be said that the quality of "Isophotal" is not (as the inventor would seem to imply by the title of the paper) by any means peculiar to this instrument, those of Riddell, Nachet, Stephenson, and Ahrens, being equally "isophotal."

We are fortunate in having been for some years the possessor of one of these instruments, which we preserved, not so much on account of the "Isophotal" prism, as for the mechanical curiosity of the arrangement by which "the two equally inclined bodies of the Microscope swing on a pivot at their junction to such an extent as to bring one of them vertical, when the instrument becomes a monocular by merely withdrawing the prism." This motion, Mr. Holmes says, "was *first* devised by me for this Microscope."

Mr. Wenham subsequently pointed out* the incompleteness of the article in regard to the binocular Microscopes previously made (Nachet's existing form and others being omitted), and also that the "Isophotal prism" is the same as that devised by himself in 1860.†

Mr. Holmes, in reply to Mr. Wenham's first note, wrote: ‡—

"Matters of date have nothing to do with the subject, there being

* 'Engl. Mech.,' xxxi. (1880) pp. 500 and 569.

† See 'Mon. Micr. Journ.,' 1874, p. 129.

‡ 'Engl. Mech.,' xxxi. (1880) p. 516.

no question of priority in dissimilar inventions. My prism does not claim to be either a copy of, or an improvement on, Mr. Wenham's prism of 1860, as he appears to suppose, but is substantially an independent invention, made ten years later (1870) in total ignorance of Mr. Wenham's prism. . . . And I have only to say, in conclusion, that my prism is as different from Mr. Wenham's prism as a Huyghenian eye-piece is different from a Ramsden eye-piece."

**Nachet's Microscope with Rotating Foot.**—A Microscope was devised some time ago by M. Nachet to embody a rotatory motion in azimuth around the mirror. This was effected as follows:—

The base of the stand was a solid disk of metal, in the centre of the face of which the mirror was attached with Nachet's usual articulations, permitting free motion in all directions. Near the edge of the base a circular groove was made, into which the foot of the Microscope proper—a ring of metal carrying the pillar support, as in the Bockett lamp—was fitted, and made to rotate easily. The centre of this circular foot was made coincident with the optic axis of the Microscope. It is obvious that so long as the object remained in the axis of rotation (which was secured by the Microscope being used in a vertical position), the azimuthal rotation around the mirror was practically perfect, except just where the pillar of the stand intercepted the light on the mirror; and the varying effects of light due to this motion, when the mirror was placed excentrically, could be observed with facility.

The stand was intended to provide in the simplest form the equivalent of a perfectly concentric rotating stage, such as is adapted to M. Nachet's more elaborate stands. We have never understood why this inexpensive form of Student's stand has been withheld from popular appreciation.

**Edmunds's Parabolized Gas Slide and Nachet's Gas Chamber.**—Dr. Edmunds claims that everything which can be accomplished by means of the latter apparatus * may also be accomplished by the parabolized gas slide.†

For the study of such coarser microscopical objects as do not need the black-ground effects of the immersion paraboloid, it is necessary only that a ring of tin-foil, wax, or shellac be interposed between the margin of the thin cover and the top of the slide, oil or grease being still used to seal up the interspace. Thus the thin cover and the film of material under observation is lifted away from immersion contact with the top of the central paraboloid, and gaseous reagents act instantaneously upon the object. If also a slender ring of cotton or silk be packed into the bottom of the annular channel, it serves to hold water and keep up the humidity of the object when, from any cause, it is less convenient to pass gaseous reagents over a piece of wet cotton-wool before entering the annulus of the slide.

Dr. Edmunds also considers that the gas chamber introduces a practical difficulty, inasmuch as on changing the reagent it takes a long time to sweep the chamber clear of its previous contents, and

* See this Journal, *ante*, p. 707. † Ibid., p. 585.

therefore it becomes difficult to determine the point at which the effects of the various reagents begin and end. On the other hand, in the gas slide the annular channel is a mere continuation of the tube, and is instantly swept clear, so that the effects of various reagents mark themselves off sharply.

**Advantages of the Binocular Microscope.**—Very varied opinions exist as to whether the binocular Microscope is or is not of practical value in histological investigations. Such authorities as Professors Huxley * and Lankester in England, Professor Ranvier in France, † and the German biologists almost without exception have pronounced against it. Nevertheless there is undoubtedly a large class of cases in which the binocular Microscope is of the greatest use in the ready recognition of the true structure of an object, and this is especially so in transparent objects in which the precise position of one part above or below another can be recognized by means of a binocular with exceptional facility, and as is said by the writer of the paper next referred to, "there is no difficulty in deciding whether a fine nerve-termination passes over or under or *into* a connective-tissue corpuscle." Several cases occurred during the last scientific session in which it was clear that the observers had failed to appreciate the true relation of the parts of the object in consequence of the use of a monocular instrument.

Whilst, however, we object to the view that the binocular is not of value in biological investigations, we have to call attention to the necessity of avoiding an error of an opposite kind, viz. of laying too much stress on the perfection of the stereoscopic effect when objectives of *high angle* are used. An instance of this is to be found in a recently published paper,‡ the writer of which refers to the "bold relief" obtained with a Wenham prism used with an objective of high angle. Cells are described as being seen, "not as flat plates, but as spheroidal bodies." Now Dr. Carpenter long ago pointed out § that with large angles the effect of projection is so greatly exaggerated, that in the case of perfectly spherical objects the side next the eye instead of resembling a hemisphere looks like the small end of an egg. "Hence," he says, "it may be confidently affirmed—alike on theoretical and on practical grounds—that when an objective of wider angle than 40° is used with the stereoscopic binocular the object viewed by it is represented in exaggerated relief, so that its apparent form must be more or less distorted."

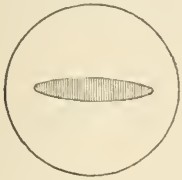
In addition, it may be noted that high-angled objectives having little "penetration" produce a false sense of stereoscopic effect by reason of the parts of the object which are within and without the focus being larger than those which are in focus.

**Reduction of Angle of Aperture with the Binocular.**—Microscopists should bear in mind that it is only in *one direction* that the binocular reduces the angle of aperture of objectives. If for instance

* 'Journ. Quek. Micr. Club,' v. (1879) p. 146.
† See this Journal, i. (1878) p. 149.
‡ 'Quar. Journ. Micr. Sci.,' xx. (1880) p. 318.
§ 'The Microscope and its Revelations,' 5th ed. (1875) p. 69.

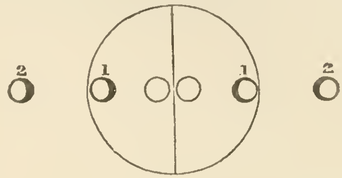
an object have parallel lines upon it, and these lie in a direction from the back to the front of the stage, the diffraction spectra will be arranged in a row at right angles to the lines, and half of the spectra which would otherwise have been admitted will be cut off by the

Fig. 88.



Object.

Fig. 89.



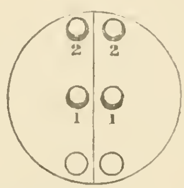

Spectra.

prism (Figs. 88 and 89). If, however, the object is turned round so that the lines run from left to right, the row of spectra will be admitted (Figs. 90 and 91), and there will consequently be no diminution of aperture.

Fig. 90.

Object.

Fig. 91.




Spectra.

If the number of lines in the object were doubled, the distance between the spectra would also be doubled, and the spectrum No. 1 in Fig. 89 would occupy the place of No. 2, and would thus fall outside the field, and there would be no resolution. On turning the object round, however (see Figs. 90 and 91), the spectrum No. 1, though more widely separated from the central illuminating beam by reason of the greater fineness of the lines would still fall within the field (occupying the place of No. 2) and the object would be resolved.

It is therefore of practical importance to see that the object is properly placed when a binocular is used.

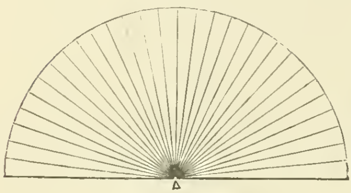
Apertures exceeding 180° in Air. — Many microscopists still experience a difficulty in grasping the idea of an object-glass having an aperture "exceeding 180° in air," but a little consideration should dispel any difficulty.

Fig. 92 represents the theoretical maximum of 180° in *oil* or other homogeneous fluid. It is a semicircle, enclosing 30 spaces, radiant from the point A (of 6° each), spread out as a fan, through which the diffraction spectra emanating from A may be supposed to pass.

If we now substitute for the oil a fluid, such as *water*, having a lower refractive index, the radiant spaces will become wider, and can therefore no longer be contained in the semicircle, as is shown in Fig. 93. The fan will have opened out, and instead of the original 30 spaces there will be only $26\frac{2}{3}$, the other $3\frac{1}{3}$, outside the semicircle, being excluded.

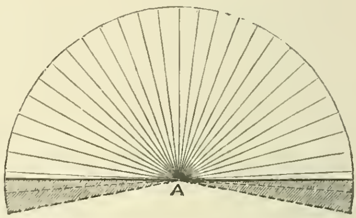
If we now substitute *air*, we shall have a further widening of the radiant spaces; the fan will have been yet further expanded (as

Fig. 92.



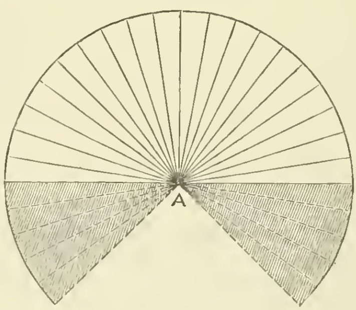
Oil.

Fig. 93.




Water.

Fig. 94.




Air.

shown in Fig. 94), arising from the still lower refractive index of air, and the semicircle will contain no more than 20 spaces, 10 of them being now beyond the 180°.

It will therefore be seen that while an aperture of 180° in air includes (in the illustration given) only 20 radiant spaces, 180° in water and oil include respectively $26\frac{2}{3}$ and 30, these numbers representing the respective apertures in air, water, and oil, the *smallest* number (20) representing, as before stated, 180° in air.

The whole confusion has arisen from not getting beyond the simple and obvious fact, about which there can be no dispute, that a *dry* lens cannot have an aperture of more than 180°. That which is not appreciated is the fact that by substituting for the air of the dry lens either water or some other more refractive medium than air, the conditions are entirely changed, and that "aperture" is not a question of "*angles*," simply as angles, at all.

**Diameter of Microscope-tubes.**—In a paper read two or three years ago to the San Francisco Microscopical Society (now first published *), Dr. J. H. Wythe says that the diameter of the Microscope-tube has an important relation to the distinctness and luminosity of the image. Few tubes are wide enough to utilize more than a small proportion of the rays proceeding from an objective. The field-glass of the eye-piece should be of the greatest diameter possible for its focal length, and the tube wide enough to receive it, in order to concentrate the greatest number of rays from the objective. The short tubes of French and German Microscopes are supplied with narrow eye-pieces, which cut the cone of rays nearer the objective, and give a more brilliant image than would be possible in a longer tube. If the tube be longer, it must also be wider, and the eye-piece of corresponding diameter.

**Wythe's Amplifiers.**—Dr. Wythe in the same paper proceeds to explain his views as to the construction of amplifiers, some of which he exhibited to the Society, which were considered to be a great improvement upon any previously seen.

"In considering the construction of the Microscope with a view to greater amplification by the eye-piece, it occurred to me that the concave lens or meniscus used to diverge the rays of the objective should form a part of the eye-piece, and be of as large diameter as the tube will allow. If it be of small diameter, it must be placed nearer the objective. This is the form and position of the amplifiers of Tolles, Zentmayer, and others.

One of the amplifiers, exhibited by me to the Society on a previous occasion, consists of a conical meniscus, whose position in the tube and effects correspond with the amplifiers above named. With this simple addition placed in the lower end of the draw-tube the magnifying power of an objective can be nearly doubled with little loss of light or of definition.

The other form of amplifier now exhibited is still better. A double concave lens, or meniscus, of as great diameter as the tube will allow and of considerable diverging power, is placed at a distance of from 2 to 4 inches in front of the eye-piece. In the improved form in which I now present it, a concave meniscus of 6 inches equivalent focus and $1\frac{1}{2}$ inch diameter (which formerly served as part of the object-glass of a small telescope), is placed in a draw-tube at the end next the eye-piece and about 3 inches from the latter. To counteract the aberration of the amplifier, I have sometimes substituted for the plano-convex field-glass of the Huyghenian eye-piece a convex meniscus of short focus, which gives also a very wide and flat field of view. Ordinary eye-pieces and the periscopic eye-pieces of Gundlach may also be used with the amplifier. The amplifying eye-piece, thus constructed, has given me great satisfaction. If the concave meniscus were made achromatic, it would doubtless be

* 'Am. Journ. Micr.,' v. (1880) p. 81.

a still further improvement, yet the performance of the eye-piece leaves little to be desired. The wavy, basket-like, longitudinal striæ on *Surirella gemma* and the hexagons on *P. angulatum* are well seen with a $\frac{1}{4}$ objective, and the *Frustulia Saxonica* and *A. pellucida* (dry) have been resolved by it with a non-adjusting $\frac{1}{8}$ of Gundlach's.

In place of the concave meniscus referred to, I have also used, with nearly as good effects, a double concave lens of 2 or 3 inches equivalent focus, such as can be obtained at an optician's for about 50 cents. So that by a very small cost of time and money, the possessor of an ordinary objective may increase the power of his instrument to a very great degree.

I reiterate the conviction before expressed, that further improvement of the Microscope may be looked for in the construction of eye-pieces—regulating their magnifying power and increasing their diameters so as to concentrate rays from the objective, which are now absorbed by the sides of the tube."

Foreign Mechanical Stages.—We described and illustrated at pp. 712–13 (Figs. 60–1) a mechanical stage (by Schmidt and Haensch), which was claimed to be a great improvement upon other stages, and the action of which, as regards the movement of the object in two rectangular directions, and the proof that thereby every part of the object must certainly come into the field of view, were given with extreme minuteness, as if the idea of a mechanical stage with rectangular movements had only now dawned upon microscopists.

The matter has now been carried a step further, and we are brought somewhat nearer to the present day by the two stages described below, and which are represented to be better than the English stages in several important particulars. As the description * would suffer by any abstract, we have given a full translation. The writer (Dr. E. Kaiser, of Berlin) first refers to the above Microscope of Schmidt and Haensch,† and its arrangement for exact centering of the tube whilst focussing, and then proceeds as follows:—

" We Germans have hitherto fitted up our Microscopes in a most meagre way as regards mechanical accessory apparatus. If we compare our instruments in this respect with those made on the other side of the Channel, we must certainly confess that ours are far excelled by the English ones. We have always consoled ourselves for this with the idea that the numerous mechanical appliances of the English instruments are really only playthings which are never in any case *necessary*. But nothing is so erroneous as this idea. The so-called 'substage' of the English, their provisions for the fine adjustment and mechanical motion of the object, do not constitute a mere plaything in any sense, but are *absolutely* necessary and indispensable for scientific investigations. The conviction of this has gained ground with time more and more in our *scientific* circles, and to Zeiss's manufactory,

* 'Bot. Centralbl.,' i. (1880) p. 728. † See this Journal, *ante*, p. 713.

under the excellent theoretical guidance of Professor Abbe, is due the credit of being the first to take into account this new tendency.

A year ago, the firm of Schmidt and Haensch following in the footsteps of Zeiss, made improvements in the Microscope, and in particular brought out their new movable stage.

The first and oldest movable stage on Schmidt and Haensch's model was placed on the ordinary stage, and very much distinguished itself over those of English construction [i. e. the stage on p. 713 !] in being more simple, and entailing, therefore, *a higher degree of certainty and exactness* * in the work. The motion from back to front was produced by a screw, whilst the lateral motion (from right to left) was effected by a simple lever-movement. This construction did not provide, it is true, for the diagonal motion of the object, which is possible with English Microscopes, but, on the other hand, it afforded what is entirely wanting in English stages, an *absolute* guarantee that no portion however small of the preparation can escape the attention of the observer. The eminent importance of this in many scientific investigations need not be insisted upon by us.

One defect, however, of this stage of Schmidt and Haensch could not be disguised, and that was that it appeared only suitable for use with low powers. All other objections which have been brought against it, especially those of Professor Johne of Dresden,† must be met with the rejoinder that they are either empty phrases or, as the writer will prove in another place, erroneous conclusions drawn from wrong calculations and false premises.

Messrs. Schmidt and Haensch's manufactory has now produced at the instigation of the writer and by the application of an idea of Professor H. Goltzsch, two new movable stages, which are free from the reproach we have admitted above, and which ought to satisfy *all* requirements.

There is the most absolute certainty, even when the highest powers are used, that not even the minutest part of the preparation will be passed over; whilst at the same time, like the Maltwood finder, it serves to find again readily any particular point of the preparation.

An essential advantage of the new stages over English ones consists in the fact that, besides the *simplicity* and *certainty* of their construction, the larger one can also be used as a screw micrometer, and both allow of *a much greater use being made of the optical capacity of the Microscope*, on account of their being considerably thinner than the English movable stages, whereby a better adjustment of the diaphragms (e. g. raising the diaphragms to the under surface of the slide without using the condensers) is rendered possible.

The two stages are designed on a common principle, but differ from each other by one being intended for *rapid work* with low and medium powers (up to 600), whilst the other is for *exact scientific investigations and measurements*, in which the highest powers may be used.

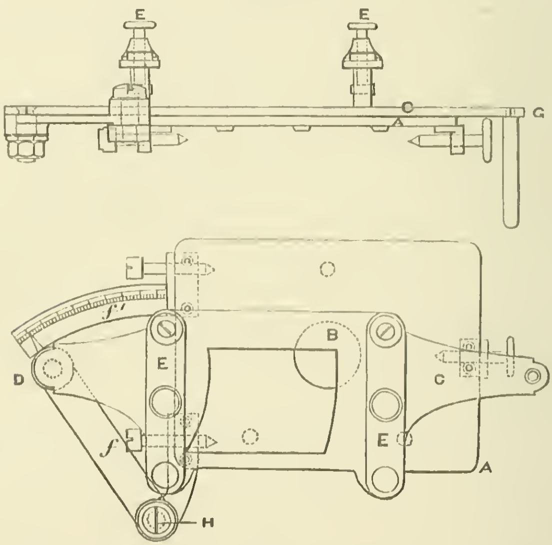
* All italics as in original text. † See this Journal, *ante*, p. 713.

Both stages are applied to the ordinary stage, and are held in position by springs.

The first stage (Fig. 95), which is the simpler of the two, consists, 1st, of a fixed plate A, with a central opening B for the usual diaphragms, and, 2nd, of the movable plate C, which turns about D, and has a larger rectangular opening.

On the plate C are two clamps E E, which serve to fix the slide. A sector *f f'* is attached to the fixed plate A, and is graduated at *f'*. The pointer *f* turns on H, and is connected at D with the movable plate C by a screw, and the plate can therefore be moved about the point D. As appears from a simple inspection of the figure, the pointer *f* (and with it of course the plate C) can be turned about H

Fig. 95.




so as to fall upon any particular division of the scale *f'*. The preparation on the slide which is fixed by the clamps E E, can therefore be moved its whole width under the objective by means of the lever movement at D, whilst the examination of the object longitudinally is effected by gradually pushing the pointer *f* along the scale *f'*.

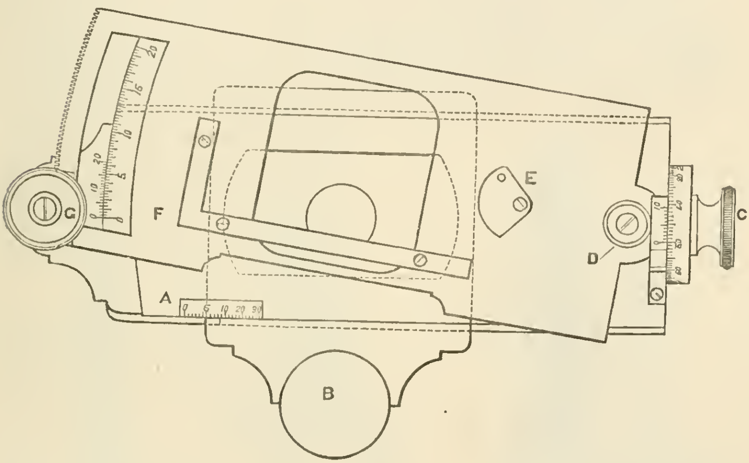
If the motion of the pointer *f* on the scale *f'* is so regulated that it moves each time over the space of the field of view, and if after every such movement the preparation is examined through its whole width by turning the plate C about D, it follows that every point of the object must appear in the field; the applicability of this stage as a Maltwood finder is also thus evident.

To use the stage, for instance, for finding a given point (e. g. a diatom-frustule), it is only necessary to note the position of the pointer *f* on the scale of *f′*. Suppose a *Pleurosigma attenuatum* of a certain preparation to lie in the field when the pointer *f* was on the division 18 of the scale *f′*, and it is required to find this frustule again. Solution: Put *f* on the division 18 of *f′*, place the preparation firmly between the clamps E E, and turn the plate C about D, the *Pleurosigma* sought for must inevitably appear in the field.

A great advantage of this stage consists in its enabling the observer, by simply taking out the screw H, to move the preparation about in any direction under the objective, just as in the case of free-hand movement of the object with the ordinary stage.

The second stage (Fig. 96), which is the more complicated, and is intended for scientific investigations and for measuring, is similar in construction to the stage above described.

FIG. 96.




The plate A is dovetailed into the microscope-stage B, and by means of the divided screw C can be moved longitudinally. It has a scale at A, the divisions on which correspond to a revolution of the screw C (0·25 mm.). The drum of the screw C is divided into one hundred parts, each division having thus the value 0·0025 mm. There is also a nonius which marks the tenth part of this value.

On the plate A there is a second movable plate (on which is an excentric disk E, and the piece F for fixing the slide), movable about the screw D by the pinion at G, so that one minute may be read off directly by means of the scale and nonius.

It is not necessary to prove that the same principle is involved in the construction of both stages, and consequently that with the second stage an equally systematic, and indeed much more perfect reading off of the position of the object is possible, as with the first stage. It can also be used in just the same way as a Maltwood finder, but giving, of course, much greater precision. The divisions at A and C, as also the scale at G, give most exact and close readings for fixing the position of a given point of the object, and the stage has the advantage that the position of the point is referred not to a curved line merely, but to a particular portion of the segment of a circle which lies within the dimensions of one field.

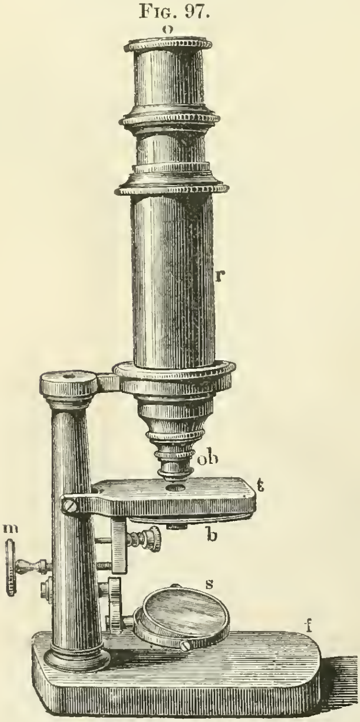
When this stage is used as an object-micrometer, it must of course (as with every screw micrometer), be used in the direction in which the screw C works. It is well only to commence measuring after the screw has been turned a little in the direction in which the measurement is being made, as only by this means can the dead-way be obviated, which is unavoidable when a screw turns backwards and forwards.

The measurements are read off directly from the divisions at A and C. At A we have a value of 0·25 mm., at C of 2·5 $\mu$, and at the nonius at C (to read which a lens is required), a value of 0·25 $\mu$.

Lastly, it should be mentioned that an objection which may rightly be urged against the first stage, and which precludes its use for exact scientific investigations, is got rid off entirely in the second form. It is this: the turning of the upper movable plate about the point D in the first stage produces somewhat excentric circles; in the second this is not the case, as the circles formed about the point D are exactly concentric."

What are the mechanical stages of English construction which have found their way to Germany, and to which the above two stages are so greatly superior?

Fig. 97.

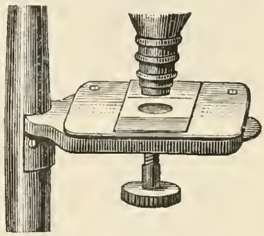



**"Fine" Adjustments.**—The crimes that are said to have been committed in the name of liberty are, we think, pretty well matched by those committed in the name of cheapness, at any rate when perpetrated in the case of such an instrument as the Microscope. Fig. 97 shows a method actually adopted in practice in a German instrument for making the fine adjustment. When the screw $m$ is withdrawn, the spring seen above the mirror presses the arm attached to the stage against the pillar of the Microscope, and the stage then takes an oblique position. When the screw $m$ is turned, it forces the arm outwards, and thus elevates the stage above the horizontal position as much as it was formerly inclined below it.

We should have supposed that whatever advantage might be gained by being able to use a high power with this instrument would be lost by the defective adjustment.

A still cheaper and still more barbarous method is shown in Fig. 98, in which the screw beneath the stage elevates the upper of two plates of which the stage is composed; the upper plate is, however, only separable from the lower plate at one side, so that in this case also the object would not lie horizontally, but obliquely; indeed, by reason of its thinness the upper plate in our instrument is more or less curved when separated.

Fig. 98.



It is perhaps fair to note that, when literally translated, these adjustments are described by the relative term of "*finer*," and that they are very cheap.

Fig. 99.

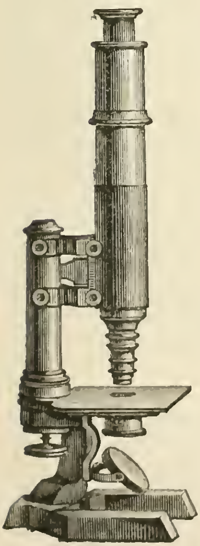


Fig. 100.

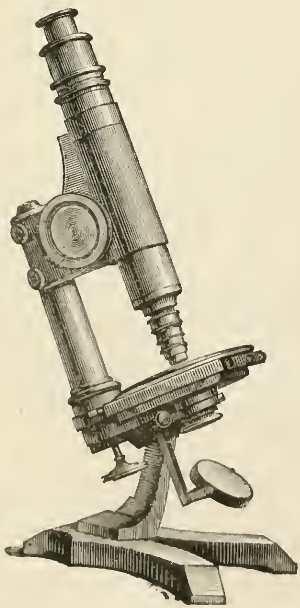
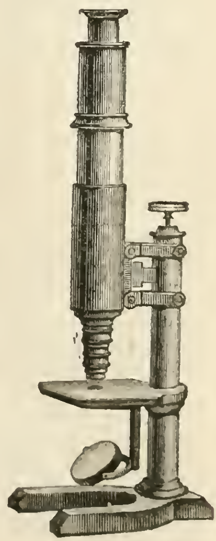


Fig. 101.



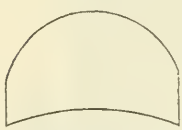
**Seibert and Krafft's Fine Adjustment.**—It is claimed for this contrivance that it acts without friction. Three different forms are shown in Figs. 99, 100, 101.

The tube is suspended from two parallel arms, whose terminal points are movably connected with both the pillar of the microscope and the tube itself. These arms with medium adjustment are exactly horizontal; but if the tube is raised or lowered by means of the micrometer-screw, which acts upon a projecting piece between the arms, the latter assume a slightly oblique position. The movement effected by means of the screw corresponds therefore to the displacement of a parallelogram of which one side remains fixed in a vertical position while the opposite side is slightly raised or lowered, still preserving the parallelism. Since the displacement takes place between the points of eight screws, any shifting of the image is entirely avoided, and friction is reduced to a minimum. In consequence of this the micrometer-screw turns very easily, and dead-way is avoided with equal resistance on both ends.*

**Construction of Immersion Objectives.**†—The following note is by Mr. Wenham, and we therefore give it verbatim (with the woodcut), though we are not sure that we altogether understand what is meant to be conveyed, especially in regard to dispensing with the use of oil. No alteration of the front of an objective can, as it seems to us, ever make a water-immersion objective equal in aperture an oil- (homogeneous) immersion :—

"From the above ‡ it may be inferred, that if the front of an object-glass, in cases when the aperture is supposed to be limited by water from rays reflected back and increased by an intermedium of oil of cedar or cloves, if the first surface is also made concave, it would be the means of dispensing with the objectionable use of oil. I have tried some experiments this way. Fig. 102 is the front lens of an immersion $\frac{1}{10}$-inch object-glass. At first the concave surface of the front was made much shallower than is shown, without any appreciable difference in effect from that of a flat plane. The concave was then deepened till it reached to near three times that of the hemispherical back radius, with a slightly improved result in the way of increase of light and flatness of field. The experiment was not carried further. The radius of the back convex is ·045, that of the concave ·13. Of course if oil of the same optical properties as the glass were to be used, the effect of the concave surface would be simply nil. It would then act like a flat front."

Fig. 102.



**Mounting of the Front Lens of Immersion Objectives.**—Messrs. Powell and Lealand claim to have made a water-immersion $\frac{1}{4}$, with a numerical aperture of 1·30 or 155° (the theoretical maximum being 1·33 or 180°).

To obtain this aperture the plan described by Professor Abbe § is

* Nägeli and Schwendener, 'Das Mikroskop,' 2nd ed.
† 'Am. Mon. Micr. Journ.,' i. (1880) p. 101.
‡ A description of the construction of the immersion-paraboloid.
§ See this Journal, ii. (1879) p. 821.

adopted. The front lens is greater than a hemisphere, and the surface is active in the production of the image up to several degrees beyond the equator, so that the lens is mounted on a thin glass plate, and the slightly prominent edge of the latter fixed to the brasswork of the objective.

"F. R. M. S.," writing on this subject, says:*—"This plan of mounting front lenses on a thin plate of glass so that the setting need not encroach on the active spherical surface, seems to have been known to and practised by the late Andrew Ross in connection with dry lenses. Some ten years ago Tolles, of Boston, experimented with this plan of mounting, for water-immersion lenses. But I believe it is not on record that either Ross or Tolles ever attempted to utilize a front lens beyond the hemisphere.

The first notice I have met with, relating to the possible use of a front lens greater than a hemisphere, is in a paper 'On the Question of a Theoretical Limit to the Apertures of Microscopic Objectives,'† by Professor G. G. Stokes, of Cambridge. Professor Stokes there discussed the question from a theoretical point of view, and gave a demonstration, based on the assumption that such a front lens could be utilized, proving the possibility of apertures approximating to 180°, measured in the body of the lens.

The first practical development of this idea—whether suggested by Professor Stokes's paper or not, I am unable to say—was projected by Professor E. Abbe, of Jena University, and successfully applied by Zeiss, the optician, of Jena, under Professor Abbe's direction, to extend the apertures of homogeneous-immersion objectives to the highest point hitherto attained, 1·4 numerical ap. (= 134°, nearly, measured in crown glass of mean index 1·525).

In June 1879, Professor Abbe brought over to England one of these high-angled $\frac{1}{8}$ objectives. He explained at the R. M. S. that he had found it necessary to prepare a special immersion fluid (an aqueous solution of chloride of zinc) for use with the new lens, because he had not found it possible to obtain satisfactory correction of the aberrations with any of the refractive fluids previously in use. Even with the zinc solution he found it important to improve the corrections by a novel chromatic refracting device of his own contrivance, to be placed immediately below the eye-piece. While this immersion medium remained in the desired condition, the definition obtained with the lens was remarkably good; but, unfortunately, the solution quickly became turbid and useless, so that Professor Abbe did not venture to exhibit the lens at work in public. He stated that the difficulties of construction would probably preclude Mr. Zeiss from making such lenses for sale. I had the good fortune to see the lens tested under the most favourable conditions, and can affirm that it produced excellent results.

In certain demonstrations conducted by Professor Abbe he pointed out the fact that the new lens could be utilized for proving the refractive indices of various immersion fluids; for example, using

* 'Engl. Mech.,' xxxi. (1880) p. 517.
† See this Journal, i. (1878) p. 139.

water, he obtained the precise numerical aperture 1·33 (= double the "critical angle," 62° 58′, from crown glass to water), &c. With air as the external medium at the plane-front of the lens, the num. ap. 1·0 was exactly shown (as, indeed, it is with all immersion objectives having num. ap. greater than 1·0, i. e. greater than corresponds to the maximum air-angle, 180°).

In applying this kind of front lens to the water-immersion system, Messrs. Powell and Lealand have distinctly had in view to extend the aperture to the maximum *with water as the immersion medium.* The new $\frac{1}{4}$ has an aperture so near the limit (123° out of a possible 126°),* that it may be taken to exhaust the problem of aperture—so far as it can be exhausted with the condition that the aberrations must be corrected *with water as the inter-medium,* and with that *initial power* of magnification. It is to be hoped that a similar aperture will be obtained with a much higher initial power of magnification—say, $\frac{1}{8}$, $\frac{1}{12}$, $\frac{1}{16}$, and $\frac{1}{25}$, which will practically close the water-immersion question until new refracting media are experimented with.

There can be no doubt that the development of the homogeneous-immersion system is the problem of the future as regards attaining the limit of visibility with the Microscope. In view of the success that has attended the construction of the new $\frac{1}{4}$ water-immersion, with a front lens greater than a hemisphere, Messrs. Powell and Lealand have not hesitated to engage themselves to construct a $\frac{1}{12}$ on a similar formula, but for homogeneous immersion." The objective has since been completed, and has an aperture of 142° (measured in a crown glass semi-cylinder of mean index 1·5 nearly), with a focal distance of ·007 inch.

**Penetration.**†—Dr. Blackham protests against objectives with penetration, the amount of which he contends increases with the amount of spherical aberration in the objective which has been left uncorrected, and decreases in proportion as the corrections for spherical aberration approach perfection. Penetration, he maintains, produces a melting together or con-fusion of the images and a necessary loss of definition; and he appears to consider Dr. Carpenter's recommendation of focal depth in objectives as inconsistent with his statement that the "defining power of an objective mainly depends upon the completeness of its corrections, . . . an attribute essential to the satisfactory performance of any objective, whatever be its other qualities." He also combats the suggestion that as the human eye has considerable penetrating power, that quality must also be good for objectives. He points out (1) that the eye is in fact possessed of penetrating power to a much less degree than is generally supposed, this being confounded with the power of *accommodation,* by means of which the eye can be successively focussed with great rapidity upon objects at different distances; and (2) that the optical conditions in regard to the relative distances of the object and image being reversed, it does

* Or 118° and 122° if the index is taken as 1·52.

† 'Am. Journ. Micr.,' v. (1880) p. 145.

not follow that, admitting a certain amount of penetration to be useful in the eye, the same is true with the objective.

As to the view that objectives with penetrating power enable us to see the parts of objects in their true and natural relations, and that the greatest part of histological work is being done with them to-day, he replies, "the more is the pity, because most of it will have to be done over again with better lenses." The fallacy that such objectives enable us to see different planes of objects in their true relations arises from confounding depth of focus with stereoscopic effect, the latter not being dependent upon the former. Diagrams are given of two pieces of wire netting, in squares of different patterns, which are supposed to be laid over one another. "With a corrected objective you see the upper one first, and following nature's plan with the eye, you focus down through it and see the other. If both are seen at once, as a penetrating objective would do, we get a compound figure totally unlike either—an illusion of sight."

**Tolles's Improved Traverse-lens, Illuminating and Aperture-measuring Apparatus.**—Mr. Tolles has improved upon the traverse-lens which he described in 1879,* and his new apparatus is shown in Fig. 103. The following description is supplied by him :—

The apparatus being intended for measurement and use of the largest apertures, a nearly semicircular sector-plate became a necessity.

For more convenient use, a small stage *c* is supplied, but this stage and its accompanying traverse-lens *b* are readily removable. The traverse-lens *b* is less than a hemisphere by the thickness of an object-slide—assumed ·05 inch.

For convenience of mounting in its cell, the top surface of *b* has a curvature moderately convex, but with a medium of the index of glass connecting the lens and slide, the curvature is neutralized.

When the object to be viewed is in position, it is of course in the centre of motion of the illumination apparatus, as guided by the groove in the plate A. The semicircular rim of the plate is graduated to degrees, and numbered each way from the zero point (midway from the ends) to nearly 90°.

When the truncated cone of glass *k*, having immersion contact with the traverse-lens *b*, is moved from zero to the degree of obliquity where the light fails to give view of the object through the objective, at the eye-piece of the Microscope, then the half angle of interior aperture can be noted by means of an index at the edge of the plate *h*. If desirable, the half angle on the other side of the axis can be ascertained in the same manner, the cone *k* being first transferred to the fitting on which the prism *n* is shown in the figure.

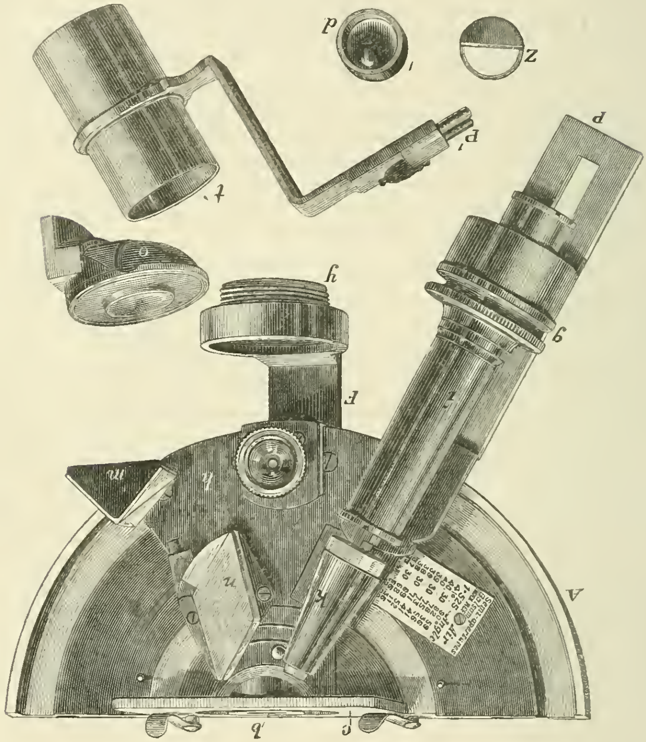
The outer end of the cone *k* can be cut off by means of a cup *z*, with a semicircular opening so as to limit the light to an axial direction *in the cone*. For greater accuracy the apparatus includes an extra arm *p* and *p'*, for carrying a small candle in the tube *t* as a radiant, and which attaches to the plate *h* in place of the prism *m*. This arm

* See this Journal, ii. (1879) p. 388.

also carries an adapter *g* for the reception of objective, having the standard screw, so that any suitable objective can be used as a condenser.

But in taking angles with the candle-radiant in use, a tube *i*, of

FIG. 103.



A, grooved semicircular plate. *b*, traverse-lens fitted to stage *c*. *c*, stage on which the object is clamped. *d*, condensing lens fitting on *k*. F, elbow-arm for attachment of the whole apparatus to the substage of the Microscope. This attachment is effected by means of an adapter *y*, or can be fitted with rack movement. *g*, an adapter for auxiliary tube, or to carry an objective as a condenser. *h*, a plate on which is mounted various apparatus for directing and condensing light upon the object. *i*, auxiliary tube for measuring apertures. *k*, a solid glass cone, concave at the smaller end (for immersion contact with the traverse-lens *b*) and plane at the other, upon which a condensing lens *d* fits, or the semicircular diaphragm *z*. *m*, a rectangular prism, to give direction to the light axially upon *k* or *n*. *n*, a reflecting prism (acting with two internal reflections), to give very great obliquity of the illuminating ray with moderate movement of the plate *h* out of the axial position, or the *zero* position. *o*, a *hemispherical* traverse-lens, for use in measuring the widest possible interior angles, with intervening medium of index 1·525; it fits in the position occupied by *b* and *c* in the figure. *p*, a radial arm extending from the plate *h*. *p′*, arm for candle fitting in tube *t*. *b*, *c*, *k*, *m*, *n*, and *p*, are removable.

some two inches in length, is mounted in this adapter between the radiant and the cone $k$. This tube has only a narrow central slit opening at each end, which slits being brought coincident in direction with the candle-flame, permit only a thin sheet of light to pass to the object. This restriction of the incident light, though not practically important in taking interior angles, *shuts out any question of accuracy.*

The extra traverse-lens $o$ is made a *hemisphere*, so as to dispense with the object-slide; traverse-lens $b$ and stage $c$ being removed, and lens $b$ replaced with traverse-lens $o$.

The object is mounted on the plane surface of this hemispherical lens under a cover-glass, and all cemented with balsam of 1·525 index of refraction. The cone $k$ has immersion contact as before, and the cone and all the illumination apparatus can be brought round to 90° of axial obliquity without coming in contact with *slide* or stage.

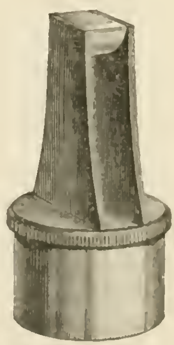
This last-described arrangement of radial-arm and radiant is especially useful in taking air apertures with dry mounted objects under view.

My method is this:—Selecting a cover-glass of ¾ inch or larger diameter, I place at any marginal part of the cover a little diatomaceous material, add a drop of alcohol to distribute the same, and by burning off the alcohol the objects adhere sufficiently to the surface.

This cover-glass is then to be cemented to a slide, not at the centre, but projecting over the end more than half its breadth, the diatomaceous *mount* being most distant from the slide-end. At about the centre of the slide, another cover of similar thickness should be cemented, so as to bring the slide to parallelism with the face of the back-stage (part of $c$ in figure) when placed with the cover-glasses downward upon it. The slide is then moved to bring the mounted objects into the optical axis, and the objective focussed upon them, with correction in some way for cover thickness.

Under these circumstances, with *nothing* intervening between radiant and object, when we restrict the light that illuminates the object to what can pass through the narrow slits at the ends of the tubes mounted on the radial arm $p$, there can remain no question of the *obliquity* of the illuminating rays that give us view of the object; *for rays of no other obliquity are admitted.*

FIG. 104.



**Semi-cylinder Illuminator.** — Mr. J. Mayall, jun., sends us the accompanying figure, showing a convenient way of mounting a semi-cylinder, or prism, &c., to be used for oblique illumination in the substage of those stands that are not provided with swinging motion. The mounting permits the semi-cylinder to be tilted and placed excentrically; in this manner, without immersion contact, by suitable adjustment, the dry object can be viewed with any colour of monochromatic light. Placed in immersion contact with the slide, the utmost obliquity of incident light can be obtained on Nobert's lines (ruled on the under surface of cover-glass in air) by refraction into the stratum of air, using a pencil incident at the upper internal surface just within the critical angle of emergence—the prismatic rays of different refrangibility being then available. Objects in fluid may be placed on the plane surface of the semi-cylinder and illuminated with ordinary transmitted light, or rendered "self-luminous" in a dark field, as with the hemispherical illuminator, prism, or Wenham's immersion paraboloid. A concave mirror with double arm is sufficient to direct the illumination. The semi-cylinder figured was made in 1875 by Mr. Tolles, of Boston, for measuring apertures. The mounting was exhibited at the Society in 1878.

**The Iris Diaphragm an Old Invention.***—It is generally supposed that the iris diaphragm, as applied to Microscopes and telescopes, is a very recent invention, but the following passage, taken from an early volume of 'Nicholson's Journal' (1804), shows that it is three-quarters of a century old:—

"Every attentive observer must have taken notice, that light is of as much consequence to artificial vision as magnifying power. It may therefore afford matter of surprise that the most variable of all adjustments of the eye, viz. that of aperture, should never be introduced into our artificial combinations. Distant woods, and other land objects, are invisible to a high magnifying power, for want of light, when the same objects may be distinctly seen with a lower. By means of an artificial iris, which an ingenious artist will find little difficulty in contriving, this disadvantage in telescopes might be obviated. Suppose a brass ring to surround the object end of the telescope, and upon this let eight or more triangular slips of brass be fixed so as to revolve on equidistant pins passing through each triangle near one of its corners. If the triangles be slidden in upon each other, it may readily be apprehended that they will close the aperture; and if they be all made to revolve or slide backwards alike, it is clear that their edge will leave an octagonal aperture greater or less, according to circumstances. The equable motion of all the triangles may be produced either by pinions and one toothed wheel, or by what is called snail-work."

**Microscopical Goniometer.**†—Mr. Rutley, referring to the Schmidt goniometer (a positive eye-piece in which a cobweb is placed with a graduated brass circle and vernier), says that when the angles of crystals occurring in sections of rock which are not very translucent have to be measured by this instrument, difficulty is often experienced in seeing the cobweb distinctly, and this is one of the most serious drawbacks to the use of this kind of goniometer for petrological purposes. Its utility would, he considers, be increased if one-half of the field were obscured by the insertion of a blackened semicircle of metal within the focus of the eye-piece instead of the cobweb.

**Pleurosigma angulatum as a Test Object.**—We continually find suggestions made in English and foreign journals that *P. angulatum*

* 'Am. Journ. Micr.,' v. (1880) p. 136.
† 'Study of Rocks' (8vo, London, 1879) p. 53.

is not now a proper test object for "high-power" objectives, and this view appears to be founded on the fact that whereas at least a $\frac{1}{8}$ objective was formerly required to resolve this diatom, it can now be accomplished by a $\frac{1}{4}$ or $\frac{1}{2}$ inch.

In the first place, there is an error in the assumption that resolution is essentially dependent upon the *power* of the objective instead of upon its *aperture*. A $\frac{1}{8}$ objective, if of only 1·1 numerical aperture, will not resolve so many lines to the inch as a $\frac{1}{4}$ of 1·15 of equal quality.

In addition to this, it is of course a mistake to consider that the test depends upon the mere fact of the resolution of the markings upon the object. For such a purpose, it is agreed that no one would now think of using it. The real test, however, is *the manner in which the image is shown*, and by the *quality* of the image of a known object the performance of objectives can be most readily determined by practised observers.

**Fasoldt's Test Plate.***—Mr. Fasoldt has, it is said, made a test plate of forty-one bands with a new machine constructed by him for the execution of fine ruling, and capable of dividing an inch into 10,000,000 parts. The first band is ruled with lines at the rate of 5000 to the inch, and the last at the rate of 1,000,000 to the inch. After the million band, there are three "test bands" ruled in 50,000 lines to the inch, but the lines cut of the same breadth and depth as those of the quarter million, half million, and one million bands respectively.

We have not yet seen any description of the plate, our information being taken from an article, "An Evening with Fasoldt's 1,000,000 Test Plate," in which the writer is rapturous over the "genius who dared not only to project, but to execute, a test so many years in advance of microscopical science."

**Günther's Photographs of Pleurosigma angulatum.**†—After the researches of Professor Abbe on the Theory of Microscopic Vision had placed it beyond doubt (writes Dr. Kaiser) that "the image of fine structures is not produced dioptrically, but by the interference of diffracted rays," there could no longer be any question that "the interference images arising from the action of diffraction do not necessarily represent the nature of the corresponding object," and therefore all attempts to determine the structure of the more difficult objects (as e. g. diatom valves) by simple inspection of their microscopical images, must be considered *à priori* as utterly futile. Rows of depressions will produce precisely the same images as actual striæ, whilst on the other hand, by striæ of different densities, may be produced the same interference-images as with an actual grating.

In order, therefore, to properly ascertain the structure of finely-organized objects, and especially to determine the structure of the diatom valves used as test objects, recourse has repeatedly been had to microphotography, which has proved an excellent auxiliary in this department of micrographic research, and in addition has to some

* 'Am. Journ. Micr.,' v. (1880) p. 160.

† 'Bot. Centralbl.,' i. (1880) p. 683.

extent furnished empirical proof of the correctness of the deductions of our theorists.

Photographs of *Pleurosigma angulatum*, in which the polygons observed on the valves show as annular depressions, have been already published by Stein in his 'Das Licht im Dienste wissenschaftlicher Forschung' (Leipzig, 1877), plate x. These photographs were not, however, taken directly from the object, but were only enlargements of a smaller microphotograph (reproduced from plate ix.) made by photographic apparatus which enlarged it with a rather objectionable effect, the original microphotograph exhibiting the well-known hexagonal markings.

To Mr. Carl Günther, a photographer of Berlin, the credit is due of having produced (exhibited at the recent International Fishery Exhibition) two photographs of *Pleurosigma angulatum* taken direct from the object, which as regards excellence of execution are at least equal to the best productions of microphotography, and which at all events are calculated to refute most thoroughly any objections which may be urged against Stein's enlargements.

Both photographs were taken by a dry process of J. D. Möller, with direct sunlight and central illumination by Abbe's illuminating apparatus, a concave lens being interposed. An old Gundlach's immersion-system No. 7 was used, and with it one of the photographs was produced with an amplification of 2000 times at the distance of 1 metre, and the other with an amplification of 5900 times at a distance of 3 metres.

In those places in which the photograph has come out perfectly sharp (and consequently in the centre especially), both photographs show, like Stein's enlargements, circular openings, with dark contour and bright centre, a circumstance which characterizes them as being without doubt "*openings*."

Where the photographs are less sharp (near the margin, therefore) the figures, which still produce the impression of openings, are more angular, whereby on a superficial examination is produced the appearance of the well-known "hatchings," running in three directions. The larger photograph shows, of course, these marked peculiarities more clearly and strikingly than the smaller one.

These photographs, it is certain, not only furnish a fresh proof of the correctness of Abbe's theory of microscopic vision; but they also plainly demonstrate the great importance of photography for the study of the more difficult microscopical structures.

**New Microscopical Journal.**—Herr Duncker, of Berlin, has commenced a 'Journal for Microscopical Examination of Flesh and Popular Microscopy' (4to), which appears twice a month. The thirteenth number, which is before us, contains articles on "Schools for the Examination of Flesh," "Micrococci and Bacteria," "The Collection and Preparing of Diatoms," &c.

# BIBLIOGRAPHY

OF CURRENT RESEARCHES RELATING TO

## INVERTEBRATA, CRYPTOGAMIA, MICROSCOPY, &c.

---

JOURNALS, TRANSACTIONS, &c., THE CONTENTS OF WHICH ARE NOTED IN THE FOLLOWING BIBLIOGRAPHY.

### UNITED KINGDOM.

#### England.

Annals and Magazine of Natural History, Fifth Series, Vol. VI., Nos. 32-3 (August-September).

English Mechanic, Vol. XXXI., Nos. 800-6; Vol. XXXII., Nos. 807*, 808-10 (July 23-October 1).

Entomologist, Vol. XIII., Nos. 207*-8* (August-September).

Entomologist's Monthly Magazine, Vol. XVII., Nos. 195-6* (August-September).

Geological Magazine, N. S., Dec. II., Vol. VII., Nos. 194-5* (August-September).

Grevillea, Vol. IX., No. 49 (September).

Hardwicke's Science-Gossip, 1880, Nos. 188-9 (August-September.)

Journal of Anatomy and Physiology, Vol. XIV., Part 4 (July).

Journal of Physiology, Vol. II., Nos. [5-6].

Journal of Science, Third Series, Vol. II., Nos. 80*-1* (August-September).

Midland Naturalist, Vol. III., Nos. 32-3 (August-September).

Naturalist, Vol. VI., Nos. 61*-62* (August-September).

Nature, Vol. XXII., Nos. 560-4, 565*, 566, 567*-9*, 570 (July 22-September 30).

Trimen's Journal of Botany, N. S., Vol. IX., Nos. 212*-13* (August-September).

London. Geological Society—Quarterly Journal, Vol. XXXVI., No. 143.

" Linnean Society—Journal (Zoology), Vol. XV., No. 82. (Botany) Vol. XVIII., Nos. [106-7].

" Quekett Microscopical Club—Journal, Vol. VI., No. 44 (August).

" Royal Society—Proceedings, Vol. XXX., No. 205.

" Zoological Society — Proceedings, 1880, Part 2. Transactions, Vol. XI., Part 2*.

Norwich. Norfolk and Norwich Naturalists' Society — Transactions, Vol. III., Part 1.

Plymouth. Plymouth Institution and Devon and Cornwall Natural History Society—Transactions, Vol. VII., Part 2*.

#### Ireland.

Dublin. Royal Irish Academy—Proceedings. Science, Second Series, Vol. III., No. 4* (April). Transactions, Vol. XXVI., Art. 22*.

---

### COLONIES.

#### India.

Calcutta. Asiatic Society of Bengal—Proceedings, 1880, No. 2*-3* (February-March).

#### Australasia.

Victoria. Microscopical Society—Journal, Vol. I., Nos. 2-3].

UNITED STATES.

American Journal of Microscopy, Vol. V., Nos. 7-8 (July-August).

American Journal of Science, Third Series, Vol. XX., Nos. 115, 116*-117* (July-September).

American Monthly Microscopical Journal, Vol. I., Nos. 7-9 (July-September).

American Naturalist, Vol. XIV., Nos. 8-9 (August-September).

Psyche, Vol. III., Nos. 73-4.

Boston. American Academy of Arts and Sciences—Proceedings, Vol. XV., Part 1*.

„ Society of Natural History—Proceedings, Vol. XX., Part 3.

Cincinnati. Society of Natural History—Journal, Vol. III., No. 2.

Philadelphia. American Philosophical Society—Proceedings, Vol. XVIII., No. 105.

St. Louis. Academy of Science—Transactions, Vol. IV., No. 1.

---

GERMANY.

Archiv für pathologische Anatomie und Physiologie und für Klinische Medicin (Virchow), Vol. LXXXI., Parts 1-2.

Archiv für Naturgeschichte, Vol. XLVI., Part 3.

Botanische Zeitung, Vol. XXXVIII., Nos. 27-33.

Botanisches Centralblatt, Vol. I., Nos. [21-2], [23-4], 25, 26-*9, 30, 31*-3*.

Entomologische Nachrichten, Vol. VI., Nos. 15, 16*-18*.

Flora, Vol. LXIII., Nos. 21, 22*-23*, 24.

Hedwigia, Vol. XIX., Nos. 7, 8*, 9 (July-September).

Jahrbücher für wissenschaftliche Botanik, Vol. XII., Part 2.

Kosmos, Vol. VII., Parts 5-6 (August-September).

Morphologisches Jahrbuch, Vol. VI., Part 3.

Naturforscher, Vol. XIII., Nos. 29, 30*-39*, 40 (July 17-October 2).

Zeitschrift für wissenschaftliche Zoologie, Vol. XXXIV., Parts 3-4.

Zoologischer Anzeiger, Vol. III., Nos. 61-5 (July 26-September 20).

Berlin. K. Preussische Akademie der Wissenschaften—Monatsbericht, 1880. April, May*, June*.

Jena. Jenaische Zeitschrift für Naturwissenschaft, Vol. XIV., Part 3.

---

AUSTRIA-HUNGARY.

Oesterreichische Botanische Zeitschrift, Vol. XXX., Nos. 8-9 (August-September).

Vienna. K. Akademie der Wissenschaften, Math.-Naturw. Classe—Sitzungsberichte, First Section, Vol. LXXX., Parts [3-4] and 5.

„ Zoologisches Institut der Universität Wien und Zoologische Station in Triest—Arbeiten, Vol. III., Part 1.

---

HOLLAND.

Amsterdam. K. Akademie van Wetenschappen—Verslagen en Mededeelingen, Second Series, Vol. XV., Part 3*.

Leiden. Royal Zoological Museum of the Netherlands—Notes, Vol. II., No. 3.

---

FRANCE.

Annales des Sciences Naturelles (Botanique), Sixth Series, Vol. IX., Nos. [5-6]. (Zoologie), Sixth Series, Vol. IX., Nos. [2-4].

Archives de Physiologie (Brown-Séquard), Second Series, 1880, No. 3 (May-June).

Archives de Zoologie expérimentale et générale (Lacaze-Duthiers), Vol. VIII., No. 3.

Brebissonia, Vol. II., No. 12 (June). Vol. III., No. 1 (July).

Bulletin Scientifique du Département du Nord, Vol. III., No. 6 (June).

Guide du Naturaliste, Vol. II., Nos. 11*–14*.

Journal de l'Anatomie et de la Physiologie (Robin), Vol. XVI., No. 5* (September–October).

Journal de Micrographie, Vol. IV., Nos. [2–3], [4–5] (February–May).

Revue Bryologique, Vol. VII., Nos. 1–4.

Revue Internationale des Sciences Biologiques, Vol. VI., Nos. 7–9 (July–September).

Revue Mycologique, Vol. II., No. 7 (July).

Paris. Académie des Sciences—Comptes Rendus, Vol. XCI., Nos. 2–7, 8*, 9–11, 12* (July 12–September 20).

„ Société Botanique de France—Bulletin, Vol. XXVI., Extraordinary Session at Aurillac, 1879; Vol. XXVII., Parts 2–3; Revue Bibliographique, Part B.

---

BELGIUM.

Archives de Biologie, Vol. I., Part 3.

Brussels. Académie Royale des Sciences, &c., de Belgique — Bulletin, Vol. XLIX, Nos. 5, 6; Vol. L., Nos. 7, 8.

„ Société Belge de Microscopie—Bulletin, Vol. VI., Nos. 6*, 7*, [8–9]*, 10*.

---

ITALY.

Florence. Società Entomologica Italiana—Bullettino, Vol. XII., Part 2*.

Modena. Società dei Naturalisti—Annuario, Second Series, Vol. XIV., Part 3.

Rome. R. Accademia dei Lincei—Atti—Third Series, Transunti, Vol. IV., Fasc. 7 (June). Memorie, Vols. III.–IV.

---

## ZOOLOGY.

### A. GENERAL, including Embryology and Histology of the Vertebrata.

Agassiz, A.—Palæontological and Embryological Development. [Address at Boston Meeting of the Amer. Assoc. Adv. Sci.] *Nature*, XXII., pp. 424–31.

Balbiani, E. G.—Fecundation in the Vertebrata (*contd.*). 1 fig. *Journ. de Microg.*, IV., pp. 53–9, 115–22.

Bellonci, G.—Researches on the Minute Structure of the Brain of the Teleostei. 6 plates. *Atti R. Accad. Linc.—Mem.*, III., pp. 258–69.

Beneden, E. Van.—Contribution to the Knowledge of the Ovary of Mammalia. Plates 20–1. *Arch. de Biol.*, I., pp. 475–550.

Beneden, E. Van, and C. Julin.—Researches on the Structure of the Ovary, the Ovulation, Fecundation, and Early Phases of Development of the Cheiroptera. Preliminary Communication. *Bull. Acad. R. Sci. Belg.*, XLIX., pp. 628–55.

„ „ „ Observations on the Maturation, Fecundation, and Segmentation of the Ovum in the Cheiroptera. Plates 22–3. *Arch. de Biol.*, I., pp. 551–71.

Frommann, C.—On the Theory of the Structure of Cells. Plate 22. *Jen. Zeitschr. Naturw.*, XIV., pp. 458–65.

Julin, C.—*See* Beneden, E. Van.

Koelliker, A.—The Development of the Germinal Layers in the Rabbit. Preliminary Communication. *Zool. Anzeig.*, III., pp. 370–5, 390–5.

Krause, E.—Notes on the Developmental-History of Embryology. II.–III. (9 figs.) *Kosmos*, VII., pp. 334–49, 419–40.

Laulanié.—Observations on the Origin of Fibrillæ in the Bundles of Connective Tissue. *Comptes Rendus*, XCI., pp. 180–2.

Moriggia, A.—Three Embryos of a Fowl in a single Blastoderm. 1 plate. *Atti R. Accad. Linc.—Mem.*, III., pp. 399–402.

Pascoe, F. P.—Zoological Classification: a handy Book of Reference, with Tables of the Sub-kingdoms, Classes, Orders, &c., of the Animal Kingdom, their Characters, and Lists of the Families and principal Genera. 2nd ed. 528 pp. (8vo. London, 1880.)

Schneider, A.—On Fertilization of the Animal Ovum. *Zool. Anzeig.*, III., pp. 426–7.

Scott, W. B.—Preliminary Communication on the Embryology of *Petromyzon*. *Zool. Anzeig.*, III., pp. 422–6, 443–6.

Yung, E.—On the Influence of Coloured Lights on the Development of Animals. *Comptes Rendus*, XCI., pp. 440–1.

Zoological Record for 1878. (8vo. London, 1880.)

## B. INVERTEBRATA.

Carter, H. J.—Report on Specimens dredged up from the Gulf of Manaar, and presented to the Liverpool Free Museum by Captain Warren (*concld.*). Plates 7–8. [Foraminifera, Spongida, Hydroida, Actinozoa, &c.] *Ann. & Mag. Nat. Hist.*, VI., pp. 129–56.

### Mollusca.

Bergh, R.—On the Nudibranchiate Gasteropod Mollusca of the North Pacific Ocean, with special reference to those of Alaska. Part II. (*concld.*). *Proc. Acad. Nat. Sci. Phila.*, 1880, pp. 121–7.

Brooks, W. K.—The Development of the Digestive Tract in Molluscs. *Proc. Bost. Soc. Nat. Hist.*, XX., pp. 325–9.

Craven, A. E.—On a Collection of Land and Freshwater Shells made during a short Expedition to the Usambara Country in Eastern Africa, with descriptions of seven new species. 7 figs. of Plate 22. *Proc. Zool. Soc. Lond.*, 1880, pp. 216–9.

" " Description of Three New Species of Land and Freshwater Shells from Nossi-Bé Island (N.W. Coast of Madagascar). 3 figs. of Plate 22. *Proc. Zool. Soc. Lond.*, 1880, pp. 215–6.

Godwin-Austen, H. H.—On the Land Molluscan Genus *Girasia* of Gray, with Remarks on its Anatomy and on the Form of the Capreolus of Lister (or Spermatophore) as developed in species of this genus of Indian Helicidæ. Plates 24–7. *Proc. Zool. Soc. Lond.*, 1880, pp. 289–99.

Hatschek, B.—On the Embryology of *Teredo*. Plates 1–3. *Arbeit. Zool. Inst. Univ. Wien*, III., pp. 1–44.

Hutton, F. W.—Manual of the New Zealand Mollusca—a Systematic and Descriptive Catalogue of the Marine and Land Shells, and of the soft Molluscs and Polyzoa of New Zealand and the adjacent Islands. 234 pp. (8vo. Wellington, 1880.)

Jeffreys, J. G.—On the Occurrence of Marine Shells of existing Species at different heights above the present level of the Sea. *Quart. Journ. Geol. Soc.*, XXXVI., pp. 351–5.

Martens, E. v.—Regeneration of the Head in Gastropods. [*Abstr.* of J. Carriere's 'Studies on the Phenomena of Regeneration in the Invertebrata. I. In the Pulmonata.'] *Naturf.*, XIII., p. 272.

" " On the Phylogeny of the Ammonites. *Naturf.*, XIII., pp. 370–1.

Owen, R.—On the External and Structural Characters of the male *Spirula australis* Lam. Plate 32. *Proc. Zool. Soc. Lond.*, 1880, pp. 352–4.

Rolleston, G.—Note on the Geographical Distribution of *Limax agrestis*, *Arion hortensis*, and *Fasciola hepatica*. [English.] *Zool. Anzeig.*, II., pp. 400–5.

SMITH, E. A.—Description of a new Species of Helicidæ from New Zealand [*Helix* (*Paryphanta*) *Gilliesii*]. *Ann. & Mag. Nat. Hist.*, VI., p. 159.

„ „ On the Shells of Lake Tanganyika and of the neighbourhood of Ujiji, Central Africa. Plate 31. *Proc. Zool. Soc. Lond.*, 1880, pp. 344–52.

VAYSSIÈRE, M.—Anatomical Researches on the Mollusca of the Family of the Bullidæ (*concld.*). Plates 4–12. *Ann. Sci. Nat.* (*Zool.*), IX., pp. 65–123.

WATSON, R. B.—Molluscan of H.M.S. 'Challenger' Expedition. V. 1 fig. *Journ. Linn. Soc.* (*Zool.*), XV., pp. 87–126.

WHITE, C. A.—On the Antiquity of certain subordinate Types of Fresh-water and Land Mollusca. *Am. Journ. Sci.*, XX., pp. 44–9.

WIMMER, A.—On the Mollusca-Fauna of the Galapagos Islands. *SB. K. Akad. Wiss. Wien*, LXXX., pp. 465–514.

YUNG, E.—On the Absorption and Elimination of Poisons in Cephalopoda. *Comptes Rendus*, XCI., pp. 238–9.

„ On the Action of Poisons in the Cephalopoda. *Comptes Rendus*, XCI., pp. 306–8.

„ On the Influence of Alkaline or Acid Media on the Cephalopoda. *Comptes Rendus*, XCI., pp. 439–40.

## Molluscoida.

DAVIDSON, T.—On the Species of Brachiopoda that characterize the "Grès Armoricain" of Brittany, together with a few observations on the Budleigh Salterton "Pebbles." Plate 10 and 3 figs. *Geol. Mag.*, VII., pp. 337–43.

GOLDSTEIN, J. R. Y.—Notes on living Polyzoa. *Journ. Micr. Soc. Vict.*, I., pp. 42–50.

„ „ A New Species of Polyzoa [*Catenicella ponderosa*]. *Journ. Micr. Soc. Vict.*, I., p. 63.

MAPLESTONE, C. M.—A new Species of Polyzoa [*Catenicella pulchella*]. *Journ. Micr. Soc. Vict.*, I., p. 64.

TRAUSTEDT.—Genera and Species of Ascidiæ simplices. *Zool. Anzeig.*, III, pp. 467–9.

UHLIG, V.—On the Liassic Brachiopod-fauna of Sospirolo near Belluno. 5 plates. *SB. K. Akad. Wiss. Wien*, LXXX., pp. 259–310.

VINE, G. R.—A Review of the Family Diastoporidæ for the purpose of classification. Plate 13. *Quart. Journ. Geol. Soc.*, XXXVI., pp. 356–61.

WATERS, A. W.—Note on the Genus *Heteropora*. *Ann. & Mag. Nat. Hist.*, VI., pp. 156–7.

„ „ Reply on the term "Bryozoa." *Ann. & Mag. Nat. Hist.*, VI., pp. 157–8.

WILSON, J. B.—Fossil Catenicellæ from the Miocene Beds at Bird Rock, near Geelong. *Journ. Micr. Soc. Vict.*, I., pp. 60–3.

„ „ On a new Genus of Polyzoa [*Catenicellopsis*]. *Journ. Micr. Soc. Vict.*, I., pp. 64–5.

## Arthropoda.

MÉGNIN, P.—Parasites and Parasitic Diseases in Man, Domestic Animals, and the Wild Animals with which they may be in contact—Insects, Arachnida, Crustacea. 63 figs. and an Atlas of 26 plates. 478 pp. (8vo. Paris, 1880.)

### α. Insecta.

BALE, W. M.—Notes on Insect Eggs. *Journ. Micr. Soc. Vict.*, I., pp. 69–71.

CANESTRINI, J.—On a singular Organ of the Hymenoptera. *Zool. Anzeig.*, III., pp. 421–2.

EDWARDS, W. H.—Experiments upon the effect of Cold applied to Chrysalids of Butterflies (*concld.*). *Psyche*, III., pp. 75–6.

FABRE, J. H.—Study on the Habits and Parthenogenesis of the Halicti. *Ann. Sci. Nat.* (*Zool.*), IX., Art. No. 4, 27 pp.

FÜGNER, K.—The Odoriferous Apparatus of *Sphinx Ligustri*. *Entomol. Nachr.*, VI., p. 166.

Hagen, H. A.—A new Species of *Simulium*, with a remarkable Nympha case. *Proc. Bost. Soc. Nat. Hist.*, XX., pp. 305–7.

Hauser, G.—Physiological and Histological Researches on the Organ of Smell of Insects. Plates 17–19. *Zeitschr. wiss. Zool.*, XXXIV., pp. 367–403.

Jaworowski, A.—On the Development of the Dorsal Vessel and of the Musculature in *Chironomus* and some other Insects. 5 plates. *SB. K. Akad. Wiss. Wien*, LXXX., pp. 238–58.

Künckel, J.—Morphological Signification of the Appendages serving for the Suspension of the Chrysalis. *Comptes Rendus*, XCI., pp. 395–7.

Lichtenstein, J.—Complement of the Biological Evolution of the Aphides of the Galls of the Poplar (*Pemphigus bursarius* Lin.). *Comptes Rendus*, XCI., pp. 339–40.

MacLeod, J.—*See* Botany A.

Mayer, P.—On certain Organs of Sense in the Antennæ of the Diptera. 1 plate. *Atti R. Accad. Linc.—Mem.*, III., 211–20.

Michels, H.—Description of the Nervous System of *Oryctes nasicornis* in the larva, pupa, and perfect state. Plates 31–6. *Zeitschr. wiss. Zool.*, XXXIV., pp. 641–702.

Moody, H. L.—Transformation of *Nacerdes melanura*. *Psyche*, III., p. 68.

Osborne, J. A.—Some facts in the Life-history of *Gastrophysa raphani*. *Entom. Mon. Mag.*, XVII., pp. 49–57.

,, ,, Parthenogenesis in the Coleoptera. *Nature*, XXII., pp. 509–10.

Poletaiew, N.—The Salivary Glands of the Odonatæ (Neuroptera). *Comptes Rendus*, XCI., p. 129.

Prentiss, A. N.—Destruction of obnoxious Insects by means of Fungoid Growths. *Am. Nat.*, XIV., pp. 575–81, 630–5.

Reichenau, W. v.—The Odoriferous Organs of the male *Sphinx Ligustri*. 9 figs. *Kosmos*, IV., pp. 387–90.

Zimmermann, O.—On a peculiar Formation of the Dorsal Vessel in some larvæ of Ephemeridæ. 4 figs. *Zeitschr. wiss. Zool.*, XXXIV., pp. 404–6.

### β. Myriapoda.

Packard, A. S., jun.—The Eyes and Brain of *Cermatia forceps*. *Am. Nat.*, XIV., pp. 602–3.

### γ. Arachnida.

Cambridge, O. P.—On some new and little-known Spiders of the Genus *Argyrodes* Sim. Plates 28–30. *Proc. Zool. Soc. Lond.*, 1880, pp. 320–44.

Croneberg, A.—On the Mouth-parts of the Arachnida. Plates 14–16. *Arch. Naturg.*, XLVI., pp. 285–300.

Emerton, J. H.—Breeding Habits of Spiders. 1 fig. *Am. Nat.*, XIV., p. 595.

Haller, G.—Acarinological Notes. Plate 17. *Arch. Naturg.*, XLVI., pp. 355–74.

MacLeod, J.—On the Structure of the Poison Apparatus of the Araneidea. Preliminary Communication. *Bull. Acad. R. Sci. Belg.*, L., pp. 110–13.

Michael, A. D.—On two Species of Acarina believed not to have been before recorded as British. Plates 6–7. *Journ. Quek. Micr. Club*, VI., pp. 107–20.

### δ. Crustacea.

Frédéricq, L., and G. Vandevelde.—Velocity of Transmission of the Motor Excitation in the Nerves of the Lobster. *Comptes Rendus*, XCI., pp. 239–40.

Grobben, C.—The Antennary Gland of the Crustacea. Plate 9. *Arbeit. Zool. Inst. Univ. Wien*, III., pp. 93–110.

Haller, G.—On some new Cymothoinæ. Plate 18. *Arch. Naturg.*, XLVI., pp. 375–95.

Man, J. G. de.—On some Podophthalmous Crustacea presented to the Leyden Museum by Mr. J. A. Kruyt, collected in the Red Sea near the city of Djeddah. [English.] *Notes R. Zool. Mus. Netherl.*, II., pp. 171–85.

MIERS, E. J.—Notice of Crustaceans collected by P. Geddes at Vera Cruz. *Journ. Linn. Soc.* (*Zool.*), XV., pp. 85–7.

MILNE-EDWARDS, A.—Note on a new species of Blind Crustacea, from great depths of the sea. *Ann. Sci. Nat.* (*Zool.*), IX., Art. No. 2, 1 p.

STEBBING, T. R. R.—*Gastrosaccus spiniferus* Goes, newly described and figured. Plate 3. *Ann. & Mag. Nat. Hist.*, VI., pp. 114–18.

VANDEVELDE, G.—*See* Frédéricq, L.

## Vermes.

BABESIN, V.—On a Nematode found in the Human Peritoneum. Plate 5, figs. 1–5. *Arch. path. Anat. & Physiol.* (*Virchow*), LXXXI., pp. 158–65.

BEAL, F. E. L.—Tardigrades and Eggs. 3 figs. *Am. Nat.*, XIV., pp. 593–4.

BELL, F. J.—On the *Pentastomum polyzonum* of Harley, with a Note on the Synonymy of the Allied Species. *Ann. & Mag. Nat. Hist.*, VI., pp. 173–6.

*Cosmovici, L. C.*—Genital Glands and Segmental Organs of the Polychætous Annelids (*concld.*). Plates 21–8. [Trans.] *Arch. Zool. expér. & gén.* (*Lacaze-Duthiers*), VIII., pp. 289–372.

DEWOLETZKY, R.—On the Anatomy of the Nemertines. Preliminary Communication I. *Zool. Anzeig.*, III., pp. 375–9, 396–400.

ETHERIDGE, R., jun.—A Contribution to the Study of the British Carboniferous Tubicolar Annelida (*concld.*). *Geol. Mag.*, VII., pp. 362–9.

FRAIPONT, J.—Researches on the Excretory Apparatus of the Trematodes and Cestodes. (Preliminary Note.) *Bull. Acad. R. Sci. Belg.*, XLIX., pp. 397–402.

" " Excretory Apparatus of the Trematodes and the Cestodes. 2nd note. *Bull. Acad. R. Sci. Belg.*, L., pp. 106–7.

" " Researches on the Excretory Apparatus of the Trematodes and the Cestodes. Plates 18–19. *Arch. de Biol.*, I., pp. 415–56.

GIARD, A.—On the Affinities of the Genus *Polygordius* with the Annelida of the Family of Opheliidæ. *Comptes Rendus*, XCI., pp. 341–3.

HATSCHEK, B.—On the Embryology of *Echiurus* and the Systematic Position of the Echiuridæ (Gephyrei chætiferi). Plates 4–6. *Arbeit. Zool. Instit. Univ. Wien*, III., pp. 45–78.

" " *Protodrilus Leuckartii.* A new Genus of the Archiannelida. Plates 7–8. *Arbeit. Zool. Instit. Univ. Wien*, III., pp. 79–92.

HINDE, G. J.—On Annelid Jaws from the Wenlock and Ludlow Formations of the West of England. Plate 14. *Quart. Journ. Geol. Sci.*, XXXVI., pp. 368–78.

HUBRECHT, A. A. W.—On the Anatomy of Nemertines. *Zool. Anzeig.*, II., pp. 406–7.

LACZKO, K.—Contributions to the Knowledge of the History of the Tetrarhynchi, principally of the Nervous System. *Zool. Anzeig.*, III., pp. 427–9.

LEUCKART.—On a case of Cestodic Tuberculose, with some Observations on the ova of *Tænia mediocanellata*. *Bull. Acad. R. Sci. Belg.*, XLIX., pp. 659–69.

MANSON, P.—Further Observations on Micro-Filariæ, with Descriptions of new Species. Plates 8–10. *Journ. Quek. Micr. Club*, VI., pp. 130–40.

MONIEZ, R.—Studies on the Cestodes. *Bull. Sci. Dép. Nord*, III., pp. 240–6.

" " On the Cysticerci of the *Tæniæ*. *Rev. Internat. Sci.*, VI., pp. 135–52.

" " Cestodes and Helminthologists. " " pp. 268–75.

PERRONCITO, E.—Helminthological Observations upon the Endemic Disease developed among the Labourers in the Tunnel of Mount St. Gothard. *Journ. Quek. Micr. Club*, VI., pp. 141–50.

POINCARÉ.—On a peculiar Alteration of Butcher's Meat. 3 figs. *Comptes Rendus*, XCI., pp. 177–9.

" On the Embryos accompanying the Cysticerci in Pork. *Comptes Rendus*, XCI., pp. 362–3.

ROSSETER, T. B.—*Floscularia ornata.* *Sci.-Gossip*, 1880, pp. 182–3.

SOMMER, F.—The Anatomy of the Liver Fluke, *Distomum hepaticum* L. Plates 27–32. *Zeitschr. wiss. Zool.*, XXXIV., pp. 539–640.

SPENGEL, J. W.—Contributions to the Knowledge of the Gephyrea. II. The Organization of *Echiurus Pallasii*. Plates 25–6, and 2 figs. *Zeitschr. wiss. Zool.*, XXXIV., pp. 460–538.

THOMAS, F.—*Synchytrium* and *Anguillula* on Dryas.
*Bot. Centralbl.*, I., pp. 761–4.
VIGUIER, C.—On the Organization of *Batrachobdella Latastii.* Plates 29–30.
*Arch. Zool. expér. & gén* (*Lacaze-Duthiers*), VIII., pp. 373–90.
*Villot, A.*—On the Organization and Development of the *Gordii.* [*Transl.* from 'Comptes Rendus.'] *Ann. & Mag. Nat. Hist.*, VI., pp. 169–71.
WILSON, E. B.—Preliminary Abstract of Observations upon the Early Stages of some Polychætous Annelides. [English.] *Zool. Anzeig.*, III., pp. 455–6.

## Echinodermata.

BELL, F. J.—Note on an abnormal (quadriradiate) specimen of *Amblypneustes formosus.* Figs. 1–3 of Plate 5. *Journ. Linn. Soc.* (*Zool.*), XV., pp. 126–9.
„ „ On the Names to be applied to certain Echinoidea.
*Proc. Zool. Soc. Lond.*, 1880, pp. 220–2.
COTTEAU, G.—On the Echinida of the Tertiary Strata of Belgium.
*Comptes Rendus*, XCI., pp. 182–3.
DUNCAN, P. M.—On a Synthetic Type of Ophiurid from the North Atlantic. Plate 3. *Journ. Linn. Soc.* (*Zool.*), XV., pp. 73–8.
FOETTINGER, A.—On the Existence of Hæmoglobin in the Echinoderms. Plate 17. *Arch. de Biol.*, I., pp. 405–13.
„ „ On the Discovery of Hæmoglobin in the Aquiferous System of an Echinoderm (*Ophiactis virens*).
*Bull. Acad. R. Sci. Belg.*, XLIX., pp. 402–4.
HAMBACH, G.—Contribution to the Anatomy of the genus *Pentremites*, with description of new species. Plates A and B.
*Trans. Acad. Sci. St. Louis*, IV., pp. 145–60.
LUDWIG, H.—The Formation of the Egg-covering in *Antedon rosacea.* 3 figs.
*Zool. Anzeig.*, III., pp. 470–1.
MILLER, S. A.—Description of four new Species of Silurian Fossils. Plate 4. [3 Ech.] *Journ. Cincinn. Soc. Nat. Hist.*, III., pp. 140–4.
SLADEN, W. P.—On a remarkable Form of Pedicellaria and the Functions performed thereby, together with general observations on the altered forms of this organ in the Echinidæ. Plates 12–13.
*Ann. & Mag. Nat. Hist.*, VI., pp. 101–14.
STEWART, C.—Note on an Abnormal *Amblypneustes griseus.* Figs. 4–6 of Plate 5. *Journ. Linn. Soc.* (*Zool.*), XV., p. 130.
WETHERBY, A. G.—Remarks on the Trenton Limestone of Kentucky, with Descriptions of new Fossils from that Formation and the Kaskaskia (Chester) Sub-carboniferous. Plate 5. [6 n. sp. Crinoids.]
*Journ. Cincinn. Soc. Nat. Hist.*, III., pp. 144–60.

## Cœlenterata.

ALLMAN, G. J.—On *Limnocodium victoria*, a new Hydroid Medusa of Fresh Water. 3 figs. *Journ. Linn. Soc.* (*Zool.*), XV., pp. 131–7.
„ „ The Fresh-water Medusa. *Nature*, XXII., p. 290.
FEWKES, J. W.—The Siphonophores (I. The Anatomy and Development of *Agalma*). 6 figs. *Am. Nat.*, XIV., pp. 617–30.
„ „ Note on the Structure of *Rhizophysa filiformis.* Plate 2.
*Proc. Bost. Soc. Nat. Hist.*, XX., pp. 292–303.
„ „ The Tubes in the larger Nectocalyx of *Abyla pentagona.* Plate 3. *Proc. Bost. Soc. Nat. Hist.*, XX., pp. 318–24.
HERTWIG, R.—On the Structure of the Ctenophora. Plates 15–21.
*Jen. Zeitschr. Naturw.*, XIV., pp. 313–457.
KERSCHNER, L.—On the Embryology of *Hydra.* Preliminary Communication.
*Zool. Anzeig.*, III., pp. 454–5.
KOCH, G. v.—Notes on Corals. Plate 16. *Morphol. Jahrb.*, VI., pp. 355–61.
LANKESTER, E. R.—The Fresh-water Medusa.
*Nature*, XXII., pp. 316–7, 361.
LAPWORTH, C.—On the Geological Distribution of the Rhabdophora. Part III. (*contd.*). *Ann. & Mag. Nat. Hist.*, VI., pp. 185–207.

*Murray, J.*—The Structure and Origin of Coral Reefs and Islands. [Abstr. of paper read at Roy. Soc. Edinb.] *Nature*, XXII., pp. 351–5.

Robinson, J. F.—The Medusa Aquarium. 1 fig. *Sci.-Gossip*, 1880, pp. 176–8.

Roemer, F.—Notes on the Genus *Caunopora* of Phillips. *Geol. Mag.*, VII., pp. 343–5.

Taylor, J. E.—Our common British Fossils and where to find them. No. XII. (Corals). 6 figs. *Sci.-Gossip*, 1880, pp. 197–8.

Weismann, A.—On the Origin of the Sexual Cells of the Hydroida. II. *Zool. Anzeig.*, III., pp. 367–70.

## Porifera.

Carter, H. J.—On Fossil Sponge-spicules from the Carboniferous Strata of Ben Bulben, near Sligo. Plate 14*b*, figs. 1–17. *Ann. & Mag. Nat. Hist.*, VI., pp. 209–14.

" " Sponges. [Including "List of Sponges dredged by the Birmingham Natural History and Microscopical Society, Falmouth Excursion, 1879, depth 15–50 fathoms".] *Mid. Nat.*, III., pp. 190–5.

Merejkowsky, C. de.—Reproduction of the Sponges by exterior budding. Plate 31. *Arch. Zool. expér. & gén.* (*Lacaze-Duthiers*), VIII, pp. 417–32.

Mills, H.—Fresh-water Sponges. *Am. Journ. Micr.*, V., pp. 125–32.

Schultze, F. E.—Researches on the Structure and Development of the Sponges. IX. The Plakinidæ. Plates 20–2. *Zeitschr. wiss. Zool.*, XXXIV., pp. 407–51.

Sollas, W. J.—On the Structure and Affinities of the Genus *Protospongia* (Salter). 2 figs. *Quart. Journ. Geol. Soc.*, XXXVI., pp. 362–7.

Vosmaer, G. C. J.—A Spongiological Bibliography. *Zool. Anzeig.*, III., pp. 478–80.

Waller, J. G.—On an undescribed British Sponge of the Genus *Raphiodesma* Bow. Plate 5. *Journ. Quek. Micr. Club*, VI., pp. 97–104.

## Protozoa.

Fullagar, J.—A peculiar Infusorian. 1 fig. [*Trachelocerca olor.*] *Sci.-Gossip*, 1880, p 181.

" " Notes on the Amœbas. 14 figs. *Sci.-Gossip*, 1880, pp. 204–7.

Kent, W. S.—A Manual of the Infusoria. Part I. 144 pp., 9 plates. (8vo. London, 1880.)

Lanessan, J. L. de.—The Protozoa. 16 figs. *Rev. Internat. Sci.*, VI., pp. 1–49.

Lapham, W. G.—*Pelomyxa palustris.* 1 plate and 3 figs. (*In part.*) *Am. Journ. Micr.*, V., pp. 152–6, 165–71.

Pantanelli, D.—The Diaspro of Tuscany and its Fossils. [Report.] *Atti R. Accad. Linc.—Transunt.*, IV., pp. 198–9.

Wilson, E.—On the Occurrence of Foraminifera in the Carboniferous Limestone of Derbyshire. *Midl. Nat.*, III., pp. 220–1.

---

# BOTANY.

## A. GENERAL, including Embryology and Histology of the Phanerogamia.

Bachmann, E.—On Suberous Growths on Leaves. Plates 7–10. *Jahrb. wiss. Bot.*, XII., pp. 191–236.

Baillon.—On a Case of Apparent Insectivorism. [*Abstr.* of paper at the Linnean Soc. of Paris.] *Nature*, XXII., p. 277.

*Behrens, W.*—On the Influence of the Movement and other Physical Properties of Water on the Behaviour of Aquatic Plants. [*Abstr.*] *Kosmos*, VII., pp. 466–71.

Bonnier, G.—On the Variation with Altitude of the Colouring Matter of Flowers in the same Species. *Bull. Soc. Bot. France*, XXVII., pp. 103–5.

Bonnier, G.—On the Quantity of Heat Disengaged by Plants during Germination. *Bull. Soc. Bot. France*, XXVII., pp. 141–4.
" " *See* Tieghem, P. Van.
Bretfeld, Freiherr v.—On the Fall of Leaves and Healing of the Resulting Scar. *Jahrb. wiss. Bot.*, XII., pp. 133–60.
Cauvet.—Second Note on the Disengagement of Carbonic Acid by the Roots of Plants. *Bull. Soc. Bot. France*, XXVII., pp. 113–16.
Comes, H.—Influence of Light on the Transpiration of Plants. *Comptes Rendus*, XCI., p. 533.
Crié, L.—Contributions to the Palæozoic Flora. *Comptes Rendus*, XCI., pp. 241–2.
D'Arbaumont.—Note on the Production of Chlorophyll in the Dark. *Bull. Soc. Bot. France*, XXVII., pp. 89–97.
De Candolle, A.—Phytography, or the Art of Describing Plants considered from different points of view. 484 pp. (8vo. Paris, 1880.)
Engelmann, G.—The Acorns and their Germination. *Trans. Acad. Sci. St. Louis*, IV., pp. 190–2.
Ettingshausen, C. Baron v.—Preliminary Communications on Phyto-Phylogenetic Researches. *SB. K. Akad. Wiss. Wien*, LXXX., pp. 557–91.
Gray, A.—Action of Light on Vegetation. *Am. Journ. Sci.*, XX., pp. 74–6.
Guignard, L.—On the Structure and Functions of the Embryonal Suspensor in some Leguminosæ. *Comptes Rendus*, XCI., pp. 346–9.
Heckel, E.—On the Action of high and moist Temperatures and of some chemical Substances (benzoate of soda, benzoic acid, sulphurous acid) on Germination. *Comptes Rendus*, XCI., pp. 129–31.
" " On deforming Pilosism in some Plants. *Comptes Rendus*, XCI., pp. 349–51.
Hegelmaier, F.—On the Suspension of Dicotyledons composed of Multinucleated Cells. *Bot. Zeit.*, XXXVIII., pp. 497–506, 513–22.
Hoffmann, H.—On the Thermal Constants of Vegetation. *Bot. Zeit.*, XXXVIII., pp. 465–71.
Lanessan, J. L. de.—The Colouring Matters and the Coloration of Plants. *Rev. Internat. Sci.*, VI., pp. 97–134.
MacLeod, J.—Contribution to the Study of the Rôle of Insects in the Pollinization of Heterostyle Flowers (*Primula elatior*). *Bull. Acad. R. Sci. Belg.*, L., pp. 27–33.
Mer, E.—On the Absorption of Water by the Leaves of Bulbous Plants. *Bull. Soc. Bot. France*, XXVI., pp. xli.–iv.
Müller, H.—Some Practical and Theoretical Remarks on F. Hildebrand's Comparative Researches on the Sap-glands of the Cruciferæ. *Jahrb. wiss. Bot.*, XII., pp. 161–9.
" " On the Development of the Colours of Flowers. *Kosmos*, IV., pp. 350–65.
Poulsen, V. A.—Botanical Microchemistry; a Guide to Phytohistological Researches for the Use of Students. 80 pp. (8vo. Copenhagen, 1880.)
Schnetzler, J. B.—On Changes in the Red Colouring Matter of *Pæonia officinalis* under the influence of Chemical Reagents. *Bot. Centralbl.*, I., p. 682.
Tangl, E.—On open Communication between the Cells of the Endosperm of some Seeds. Plates 4–6. *Jahrb. wiss. Bot.*, XII., pp. 170–90.
Tieghem, P. Van, and G. Bonnier.—Researches on Retarded Life and Dormant Life. *Bull. Soc. Bot. France*, XXVII., pp. 83–8, 116–22.
Treub, M.—Note on the Nuclei of Vegetable Cells. Plate XVI. *Arch. de Biol.*, I., pp. 393–404.

## B. CRYPTOGAMIA.

Aitcheson, J. E. T.—On the Flora of the Kuram Valley, &c., Afghanistan. [Crypt. = 30.] *Journ. Linn. Soc. (Bot.)*, XVIII., pp. 1–113.
Brongniart, C., and M. Cornu.—Note on the Cryptogams collected in the Environs of Gisors on the 16th May, 1880. *Bull. Soc. Bot. France*, XXVII., pp. 160–1.

*Eyferth, B.*—The Simplest Forms of Life (*contd.*). [*Trans.* from the German.] *Am. Mon. Micr. Journ.*, I., pp. 133–4.

GOEBEL, K.—Contributions to the Comparative Developmental-history of the Sporangia. Plate 8. *Bot. Zeit.*, XXXVIII., pp. 545–52, 561–71.

MARCHAND, L.—Pharmaco-medical Cryptogamic Botany. Part I. 138 pp., 30 figs. (8vo. Paris, 1880.)

WILLIAMSON, W. C.—On the Organization of the Fossil Plants of the Coal Measures. XI. Abstract. *Proc. Roy. Soc.*, XXX., pp. 550–4.

## Cryptogamia Vascularia.

GARDENER, J. S.—Observations on Arctic Fossil Floras with regard to Temperature. [*Gleichenia* and *Oleandra*.] *Nature*, XXII., pp. 341–2.

## Muscineæ.

BESCHERELLE, E.—Bryological Flora of Réunion and the other South African Islands of the Indian Ocean. (*In part.*) *Ann. Sci. Nat.* (*Bot.*), IX., pp. 291–380.

„ „ Bryological Flora of the Island of Nossi-Bé. *Rev. Bryol.*, VII., pp. 17–23, 33–40.

BRAITHWAITE, R.—The Sphagnaceæ or Peat-Mosses of Europe and North America. 91 pp., 29 plates. (8vo. London, 1880.)

BROTHERUS, V. F.—Bryological Excursions in the Caucasus. *Rev. Bryol.*, VII., pp. 49–58.

BRYOLOGISTS of Europe, List of. Fifth Supplement. *Rev. Bryol.*, VII., pp. 1–2.

DEBAT.—Two new Mosses? „ „ pp. 41–3.

GEHEEB, A.—Note on *Weisia Welwitschii* Schpr. „ „ p. 45.

HAMPE, E.—Selection of Exotic Mosses, new or little known, by J. E. Duby. *Flora*, LXIII., pp. 332–6.

HY.—On the Structure of the Stem in Mosses. *Bull. Soc. Bot. France*, XXVII., pp. 106–12.

LEITGEB, H.—The Sporogonium of *Archidium*. 1 plate. *SB. K. Akad. Wiss. Wien*, LXXX., pp. 447–60.

LINDBERG, S. O.—*Tortula lingulata* n. sp. *Rev. Bryol.*, VII., pp. 40–1.

„ „ De peristomio Eucalyptæ streptocarpæ et proceræ. [Latin.] *Rev. Bryol.*, VII., p. 77.

„ „ Distinctio Scapaniæ carinthiacæ e Sc. apiculata. [Latin.] *Rev. Bryol.*, VII., pp. 77–8.

MÜLLER, C.—Prodromus Bryologiæ Argentinicæ seu Musci Lorentziani Argentinici (*contd.*). [Latin.] *Rev. Bryol.*, VII., pp. 5–13, 58–64.

PHILIBERT.—Notes on some Rare or Critical Species. *Rev. Bryol.*, VII., pp. 27–8, 43–5.

RÉCHIN, J.—Bryological Glance at the Environs of Mamers (Sarthe). *Bull. Soc. Bot. France*, XXVI., pp. xx.–iii.

„ „ Report on a Bryological Excursion to Lioran. *Bull. Soc. Bot. France*, XXVI., pp. lxxix.–lxxxii.

RENAULD, F.—Note on some [12] Mosses of the Pyrenees (*contd.*). *Rev. Bryol.*, VII., pp. 2–5, 78–9.

„ „ Note on *Trichostomum* (*hydrogonium*) *mediterraneum* C. Müll. *Rev. Bryol.*, VII., pp. 79–80.

STABLER, G.—Two new British Hepaticæ [*Cesia obtusa* and *Radula Lindenbergii*]. *Trim. Journ. Bot.*, LX., p. 243.

VENTURI.—A Bryological Novelty [*Bryum calcareum* n. sp.]. *Rev. Bryol.*, VII., pp. 23–6.

„ Critical Notes on the Genus *Orthotrichum*. *Rev. Bryol.*, VII., pp. 65–76.

## Fungi.

BARY, A. DE.—On *Æcidium abietinum* (*concld.*). *Ann. Sci. Nat.* (*Bot.*), IX., pp. 257–60.

BERGONZINI, C.—On a new coloured *Bacterium*. *Annuar. Soc. Natural. Mod.*, XIV., pp. 149–58.

Boudier.—*See* Roze.
Bouley.—Observations on M. Pasteur's paper.
*Comptes Rendus*, XCI., pp. 457–9.
Brunaud, P.—Dichotomous Table of the Families of Pyrenomycetes hitherto found in the Charente-Inférieure. *Rev. Mycol.*, II., pp. 129–36.
Cooke, M. C.—Exotic Fungi. *Grevillea*, IX., pp. 10–15.
„ „ *See* Kalchbrenner, C.
Cooke, M. C., and Dr. Harkness.—Californian Fungi.
*Grevillea*, IX., pp. 6–9.
Cornu, M.—Note on some Fungi. *Bull. Soc. Bot. France*, XXVII., pp. 124–5.
„ Note on some Fungi of the French Flora.
*Bull. Soc. Bot. France*, XXVII., pp. 144–5.
„ Alternation of Generations in some Uredineæ.
*Comptes Rendus*, XCI., pp. 98–9.
Ercolani, G. B.—On Onychomycosis in Man and the Solipedes. (*In part.*)
*Journ. de Microgr.*, IV., pp. 131–6.
Fedarb, J.—Fungi and Algæ in the London Clay.
*Engl. Mech.*, XXXII., p. 39.
Gillot, X.—Note on some new or rare Fungi observed in the environs of Autun. *Bull. Soc. Bot. France*, XXVII., pp. 156–60.
„ Discovery in France of *Roesleria hypogæa* Thüm. and Pass.
*Rev. Mycol.*, II., pp. 124–5.
„ Variations in *Agaricus* (*Psathyra*) *bifrons* Berkl.
*Rev. Mycol.*, pp. 125–6.
Grawitz, P.—On the Growth of Moulds in the Animal Organism. Plate 10.
*Arch. path. Anat. & Physiol.* (*Virchow*), LXXXI., pp. 355–76.
Greenfield, W. S.—Preliminary Note on some points in the Pathology of Anthrax, with especial reference to the modification of the properties of the *Bacillus anthracis* by cultivation, and to the protective influence of inoculation with a modified virus. *Proc. Roy. Soc.*, XXX., pp. 559–60.
Harkness, Dr.—*See* Cooke, M. C.
[Hitchcock, R.]—Studies of Atmospheric Dust.
*Am. M. Micr. Journ.*, I., 135–8.
Ihne, E.—Infection Experiments with *Puccinia Malvacearum*.
*Hedwigia*, XIX., pp. 157–18.
Kalchbrenner, C., and M. C. Cooke.—Australian Fungi (*contd.*)
*Grevillea*, IX., pp. 1–4.
„ „ South African Fungi.
*Grevillea*, pp. 17–34.
Karsten, P. A.—Pyrenomycetes aliquot novi.
*Hedwigia*, XIX., pp. 115–18.
Klebs, E., and C. Tommasi-Crudeli.—Studies on the Nature of Malaria. 5 plates. *Atti R. Accad. Linc.—Mem.*, IV., pp. 172–235.
Lanessan, J. L. de.—The Saccharomycetes and the Fermentations which they cause. *Rev. Internat. Sci.*, VI., pp. 220–40.
Miquel, P.—Studies on the Organized Dusts of the Atmosphere (*contd.*). 6 figs. *Brebissonia*, II., pp. 177–95.
Pasteur, L.—On the Etiology of Anthrax. *Comptes Rendus*, XCI., pp. 86–94.
„ „ Experiments tending to show that Fowls vaccinated for "Cholera" are refractory for Anthrax.
*Comptes Rendus*, XCI., p. 315.
„ „ On the Etiology of Anthracic Affections.
*Comptes Rendus*, XCI., pp. 455–7.
Patouillard, N.—On the Conidial Apparatus of *Pleurotus ostreatus* Fr. 1 fig. *Bull. Soc. Bot. France*, XXVII., pp. 125–6.
„ „ Note on some Fungi of the Environs of Paris.
*Bull. Soc. Bot. France*, XXVII., pp. 161–2.
Plowright, C. B.—*Boletus sulphureus* and *Helvella infula* at Brandon.
*Trans. Norf. & Norw. Nat. Soc.*, III., pp. 151–2.
„ „ Poisoning by *Agaricus* (*amanita*) *phalloides*.
*Trans. Norf. & Norw. Nat. Soc.*, III., p. 152.

PLOWRIGHT, C. B.—On the Occurrence of Ergot upon Wheat during the past Autumn (1879).
*Trans. Norf. & Norw. Nat. Soc.*, III., pp. 152–3.

POINCARÉ.—On the Production of Anthrax by Pasturages.
*Comptes Rendus*, XCI., pp. 179–80.

ROUMEGUERE, C.—A new eatable *Amanita*. Hypothesis of the circumstances which may render a poisonous species inoffensive. *Rev. Mycol.*, II., pp. 154–7.

„ „ Preparation by Dr. Herpell of fleshy Fungi for Study.
*Rev. Mycol.*, II., pp. 157–8.

„ „ A conidiferous *Rhizomorpha* discovered by the Abbé Barbiche. *Rev. Mycol.*, pp. 159–60.

ROZE and BOUDIER.—Contribution to the Mycology of Auvergne. Plate 3.
*Bull. Soc. Bot. France*, XXVI., pp. lxxiv.–ix.

SACCARDO, P. A.—Programme of the 'Sylloge Fungorum omnium hucusque cognitorum.' *Rev. Mycol.*, II., pp. 148–50.

„ „ Spegazzinia novum Hyphomycetum genus. [Latin.]
*Rev. Mycol.*, II., p. 140.

SALOMONSEN, C. J.—A simple Method for the pure Culture of different Bacteria of Putrefaction. *Bot. Zeit.*, XXXVIII., pp. 481–9.

SCHULZER, S.—Mycological Notes.
*Oesterr. Bot. Zeitschr.*, XXX., pp. 250–2, 286–7.

SPEGAZZINI, C.—Fungi nonnulli in insula Sancti Vincentii in die 11 Decembri 1879 lecti a C. S. [Partly Latin.] *Rev. Mycol.*, II., pp. 160–1.

THIN, G.—On *Bacterium fœtidum*: an organism associated with profuse sweating of the soles of the feet. Plate 6. *Proc. Roy. Soc.*, XXX., pp. 473–8.

THÜMEN, F. v.—Diagnoses to 'Mycotheca universalis' (*concl'd.*).
*Flora*, LXIII., pp. 323-32.

TIEGHEM, P. VAN—*Bacillus Amylobacter* in the Coal Epoch.
*Ann. Sci. Nat.* (*Bot.*), IX., pp. 381–2.

„ „ On some aggregated Bacteria.
*Bull. Soc. Bot. France*, XXVII., pp. 148–53.

„ „ Observations on the green Bacteriaceæ, on the white Phycochromaceæ, and on the Affinities of the two Families.
*Bull. Soc. Bot. France*, XXVII., pp. 174–6.

TOMMASI-CRUDELI, C.—*See* Klebs, E.

TOUSSAINT, H.—On Immunity against Anthrax acquired by preventive Inoculations. *Comptes Rendus*, XCI., pp. 135–7.

„ „ Identity of Septicemy and "Choléra des Poules."
*Comptes Rendus*, XCI., pp. 301–3.

WINTER, G.—Remarks on some Uredineæ and Ustilagineæ.
*Hedwigia*, XIX., pp. 105–10.

„ „ Mycological Notes from the Grisons. (*In part.*)
*Hedwigia*, XIX., pp. 139–41.

WOLFF, M.—On the Bacterium-theory in Illness resulting from Wounds. (*In part.*) *Arch. path. Anat. & Physiol.*(*Virchow*), LXXXI., p. 193.

## Lichenes.

ARNOLD, F.—Lichenological Fragments. XXII. *Flora*, LXIII., pp. 371–85.

LENHARRÉE, T. BRISSON DE.—Lichenological Observations. The substratum and the specific characters. *Rev. Mycol.*, II., pp. 141–5.

MINKS, A.—[On his recent work, "The Microgonidium."]
*Rev. Mycol.*, II., pp. 119–24.

PHILLIPS, W.—British Lichens: hints how to study them (*contd.*).
*Midl. Nat.*, III., pp. 196–9.

## Algæ.

CARTER, H. J.—On misdirected Efforts to Conjugation in *Spirogyra*. Plate 14, figs. 1–3. *Ann. & Mag. Nat. Hist.*, VI., pp. 207–9.

COOKE, M. C.—Additional British Desmids. *Grevillea*, IX., pp. 38–9.

FEDARB, J.—Micro-Geology. [Shrubsole's Mineralized Diatoms in the London Clay.] *Sci.-Gossip*, 1880, p. 179.

H., H. P.—The Chromatology of Diatoms. *Engl. Mech.*, XXXI., pp. 573–4.

HABIRSHAW, F.—Bibliography of the Diatomaceæ (*contd.*). *Journ. de Microg.*, IV., pp. 98–101.

*Kjellman, F. R.*—The Algæ of the Siberian Polar Sea. [*Abstr.* from 'Ofvers. af K. Vet. Akad. Förhandl.', 1879.] *Nature*, XXII., pp. 376–7.

MERESCHKOWSKY, C.—Observations on the Movements of the Diatomaceæ and their Cause. *Bot. Zeit.*, XXXVIII., pp. 529–40.

PETIT, P.—Spirogyra of Environs of Paris. 4 pp. 12 plates. (8vo. Paris, 1880.)

„ „ Discovery of Diatoms in the London Clay. *Brebissonia*, II., pp. 195–6.

„ „ Note on the Trichogyne of *Hildebrandtia rivularis* Ag. Plate 1. *Brebissonia*, III., pp. 1–5.

PHILLIPS, W.—Breaking of the Meres. Plate 134. *Grevillea*, IX., pp. 4–5.

PICCONE, A.—Catalogue of the Algæ collected during the Cruise of the 'Violante,' and especially in some small Mediterranean Islands. 2 figs. *Atti R. Accad. Linc.—Mem.*, IV., pp. 19–35.

SCHWENDENER, S.—On spiral Phyllotaxis in Florideæ. 1 plate. *MB. K. Preuss. Akad. Wiss.*, 1880, pp. 327–38.

TIEGHEM, P. VAN.—On a new ciliated Organism containing Chlorophyll (*Dimystax Perrieri*). *Bull. Soc. Bot. France*, XXVII., pp. 130–2.

WILLS, A. W.—Note on the Movement of the Cell-contents of *Closterium lunata*. *Midl. Nat.*, III., pp. 187–8.

„ „ On the Structure and Life-history of *Volvox globator*. Plate 7. (*In part.*) *Midl. Nat.*, III., pp. 209–14.

WOLLE, F.—Notes on Fresh-water Algæ (*Bulbochæte*). 1 fig. *Am. Mon. Micr. Journ.*, I., pp. 121–2.

---

## MICROSCOPY, &c.

BALE, W. M.—On covering fluid Mounts to avoid Leakage or Running-in. *Journ. Micr. Soc. Vict.*, I., pp. 57–60.

„ „ On selecting and mounting Diatoms. *Journ. Micr. Soc. Vict.*, I., pp. 65–9.

BARNARD, F.—A new Method of making Cells of Wax for mounting opaque and transparent Objects. *Journ. Micr. Soc. Vict.*, I., pp. 53–7.

BENDALL, H.—Note on a new Method of preserving the Colours of Tissues. *Journ. of Anat. & Physiol.*, XIV., pp. 511–12.

BLACKHAM, G. E.—On Angular Aperture of Objectives for the Microscope. 21 pp. 18 plates. (8vo. New York, 1880.)

„ „ Penetration: a contribution to the study of the subject. 1 plate. *Am. Journ. Micr.*, V., pp. 145–50.

„ „ *P. angulatum.* „ „ „ p. 160.

„ „ American Microscopy—Devices for Illumination. *Engl. Mech.*, XXXI., p. 518.

BRAGDON, A. A.—Honour claimed without services rendered. [Reply to Mr. Wenham.] *Am. Journ. Micr.*, V., pp. 180–3.

BROWN, J. G.—*See* Roy, C. S.

BULLOCH'S New Microscope.—*See* Fellow, &c.

BURRELL, F. S.—An Evening with Fasoldt's 1,000,000 Test-plate. *Am. Journ. Micr.*, V., pp. 160–2.

CARNOY, J. B.—Manual of Microscopy. 218 pp. (8vo. Louvain, 1880.)

CARR, E., and EDMUNDS, J.—Chromatization of Light by a Glass Plate [microscope slide]. *Engl. Mech.*, XXXI., pp. 469, 525–6.

CLEVENGER, S. V.—Microscopic Examination of Tissues after the Administration of Mercury (*contd.*). *Am. Mon. Micr. Journ.*, I., pp. 131–3.

COCKEY, C. H.—Mounting Bottle. „ „ „ p. 139.

CRAMER, C.—On the Stereoscopic Ocular of Prazmowski. [*Abstr.* from 'SB. Nat. Ges. Zurich.'] *Bot. Centralbl.*, I., pp. 927–8.

CRUS, R.—Economic Objectives—"To A. J. S."—and other Micro items. 1 fig. *Engl. Mech.*, XXXI., pp. 545–6.

CURTIS, L.—The Microscopical Examination of Signatures. *Am. Mon. Micr. Journ.*, I., pp. 124–9.

DUBY, J. E.—*See* Hampe, E.

EDMUNDS, J.—*See* Carr, E.

"Fellow of the R. Micr. Soc."—[Photograph of *Frustulia saxonica*, by Mr. S. Wells of Boston, U.S.A. 1 fig.; Powell and Lealand's newest formula ¼ Water-immersion; Inexpensive Microscopes, &c.] *Engl. Mech.*, XXXI., pp. 468–9.

" " [Powell and Lealand's newest formula ¼ Water-immersion Objective; Front Lenses greater than Hemispheres; the Abbe-Zeiss Homogeneous-immersion ⅛ of specially high aperture; Homogeneous Immersion; Micro-photography; 80,000 Diameters and American Microscopy.] *Engl. Mech.*, XXXI., pp. 517–18.

" " [Ross's improved Microscope; Swinging Sub-stage to Microscope in 1873 by Bulloch of Chicago, U.S.A.; Bulloch's new Microscope; the 10-inch Microscope-body; Abbe's Apertometer Tables. 1 fig.] *Engl. Mech.*, XXXI., pp. 567–8.

" " [Bulloch's new Microscope, 1 fig.; Fine-focussing Adjustments; Powell and Lealand's new formula Homogeneous-immersion $\frac{1}{12}$; Abbe's Dechromatizing Device for High-angled Objectives; Homogeneous-immersions with or without Correction-screw.] *Engl. Mech.*, XXXI., pp. 617–18.

" " [Powell and Lealand's new $\frac{1}{12}$ Oil-immersion; Illumination of Opaque Objects; Prodigious Magnifications in America; Achromatic Condensers.] *Engl. Mech.*, XXXII., p. 84.

FERNALD, C. H.—Method of preparing and mounting Wings of Micro-lepidoptera. *Am. Mon. Micr. Journ.*, I., pp. 172–3.

"Four Inch."—Twenty thousand diameters. *Am. Journ. Micr.*, V., p. 160.

FRAZER, P., jun.—A Mirror for Illuminating Opaque Objects for the Projecting Microscope. 1 fig. *Proc. Amer. Phil. Soc. Phila.*, XVIII., pp. 503–4.

GAGE, S. H.—Permanent Microscopic Preparations of Plasmodium. *Am. Mon. Micr. Journ.*, I., pp. 173–4.

GOLDSTEIN, J. R. Y.—On the Use of Carbolic Acid in mounting Microscopic Objects. *Journ. Micr. Soc. Vict.*, I., pp. 50–3.

HOLMES, S.—The Isophotal Binocular Microscope. 11 figs. *Engl. Mech.*, XXXI., pp. 464–5, 546.

HULL, H. V.—Glass for Slides. *Am. Mon. Micr. Journ.*, I., pp. 138–9.

KAISER, E.—C. Günther's Photographs of *Pleurosigma angulatum*. *Bot. Centralbl.*, I., pp. 683–4.

" " On some new Improvements in the Microscope-stand. 2 figs. *Bot. Centralbl.*, I., pp. 728–34.

KITTON, F.—"Dry Mounts" for the Microscope. *Engl. Mech.*, XXXI., pp. 582–3.

Lens-making. 10 figs. [From the 'Scientific American.'] *Engl. Mech.*, XXXI., pp. 513–14.

LOOMIS, B. W.—A simple and speedy Method of Staining Animal and Vegetable Sections. *Am. Mon. Micr. Journ.*, I., p. 143.

MALASSEZ, L.—On the most recent Improvements in the Methods and Apparatus for counting Blood-globules, and on a new Counter. 5 figs. *Arch. de Physiol.*, 1880, pp. 377–419.

MARTIN, A.—On a Method of direct Autocollimation of Objectives and its Application to the Measurement of the Indices of Refraction of the Glasses which compose them. *Comptes Rendus*, XCI., pp. 219–21.

'Microscopist's Annual for 1879.' No. 1, containing List of Microscopical Societies in the United States, Directory of all the Dealers and Manufacturers in the World, Tables, Rules, Formulæ, &c., useful to Microscopists. 48 pp. (12mo. New York, 1880.)

MONTIGNY, C.—Note on the Difference in the Appreciation of the apparent Size of Microscopic Images by different observers. *Bull. Acad. R. Sci. Belg.*, XLIX., pp. 670–8.

MOORE, A. Y.—Higher Magnifying Powers. *Am. Journ. Micr.*, V., pp. 174–5.

"Orderic Vital."—The Achromatic Object-glass. *Engl. Mech.*, XXXI., p. 476.

"Orderic Vital."—Lens-grinding, &c. *Engl. Mech.*, XXXI., p. 619.

PACINI, F.—On some Methods of preparing and preserving the Microscopic Elements of the Animal and Vegetable Tissues. (*In part.*) *Journ. de Microg.*, IV., pp. 136–42.

PELLETAN, J.—Immersion Illuminators. The prism of Dr. Woodward. 1 fig. *Journ. de Microg.*, IV., pp. 72–6.

" " The Camera Lucida of Dr. J. G. Hofmann for Landscapes. 1 fig. *Journ. de Microg.*, IV., pp. 76–8.

PHIN, J.—Microscopical. 80,000 diameters. *Engl. Mech.*, XXXI., p. 469. [*See* also p. 518.]

Photograph of *Frustulia saxonica.*—*See* Fellow, &c.

Powell and Lealand's newest formula $\frac{1}{4}$ Water-immersion and new $\frac{1}{12}$ Oil-immersion.—*See* Fellow, &c.

RALPH, T. S.—Annual Address of the President. *Journ. Micr. Soc. Vict.*, I., pp. 33–41.

REDDOTS, C.—Cover-glasses. *Am. Mon. Micr. Journ.*, I., pp. 123–4.

ROGERS, W. A.—On the present state of the question of Standards of Length. *Proc. Am. Acad. Arts & Sci.*, XV., pp. 273–312.

ROMEO, N. A.—A Reply to Dr. Blackham and "Four Inch." *Am. Journ. Micr.*, V., p. 185.

ROY, C. S., and J. GRAHAM BROWN.—The Blood-pressure and its Variations in the Arterioles, Capillaries, and smaller Veins. Plate 10. [Description of Methods employed, pp. 325–30.] *Journ. of Physiol.*, II., pp. 323–56.

RYDER, J. A.—Holman's new Compressorium and Moist Chamber. 2 figs. *Am. Nat.*, XIV., pp. 691–3.

S., A. J.—Economic Objectives. *Engl. Mech.*, XXXI., p. 569.

SCOTT, E. T.—Lens-making. " XXXII., p. 37.

SIDLE, J. W.—The new "Congress" Turn-table. 2 figs. *Am. Mon. Micr. Journ.*, I., pp. 162–3.

SMITH, A.—Microscopical Drawings upon Glass. *Sci.-Gossip*, 1880, p. 183.

STERNBERG, G. M.—A useful Culture-cell. 1 fig. *Am. Mon. Micr. Journ.*, I., pp. 141–3.

STODDER, C.—Reply to Mr. Wenham. *Am. Journ. Micr.*, V., p. 183.

" " The Tolles-Blackham Stand. *Engl. Mech.*, XXXI., p. 546.

STOLTERFOTH, H.—On a simple Method of cleaning Diatoms. *Journ. Quek. Micr. Club*, VI., pp. 95–6.

"Sunlight."—Centering Lenses. *Engl. Mech.*, XXXI., p. 470.

" Lens-grinding, &c. *Engl. Mech.*, XXXI., p. 569; XXXII., p. 69.

VORCE, C. M.—On Penetration. *Am. Journ. Micr.*, V., pp. 183–4.

" " Carbolic Acid in Balsam-mounting. *Am. Mon. Micr. Journ.*, I., pp. 161–2.

W.—Finishing Slides. " " pp. 122–3.

WARD, R. H.—Inaugural Address, including Remarks on the Practical Uses of the Microscope, delivered at St. James's Hall, Buffalo, N.Y., August 19th, 1879. 17 pp. (8vo. Indianapolis, 1880.)

WENHAM, F. H.—The Binocular Microscope with Achromatized Refracting Prisms. 2 figs. *Engl. Mech.*, XXXI., pp. 500–1, 569.

WEST, R. G.—Microscopic Tracings of Lissajou's Curves. *Ann. Report S. Lond. Micr. & Nat. Hist. Club*, 1880, pp. 29–30.

WHITE, J. D.—A new Injecting Apparatus. 1 fig. *Am. Mon. Micr. Journ.*, I., p. 141.

" " Improvement in making Wax-cells. *Am. Mon. Micr. Journ.*, I., pp. 150–1.

WOODWARD, A. L.—Reflection from inside of the Body-tube of the Microscope. *Am. Journ. Micr.*, V., pp. 184–5.

BI-MONTHLY.

Vol. III. No. 6.] DECEMBER, 1880. [To Non-Fellows, Price 4s.

# JOURNAL

OF THE

# ROYAL MICROSCOPICAL SOCIETY;

CONTAINING ITS TRANSACTIONS AND PROCEEDINGS,

AND A RECORD OF CURRENT RESEARCHES RELATING TO

**INVERTEBRATA, CRYPTOGAMIA, MICROSCOPY, &c.**

---

*Edited, under the direction of the Publication Committee, by*

**FRANK CRISP, LL.B., B.A., F.L.S.,**
*One of the Secretaries of the Society;*

WITH THE ASSISTANCE OF

A. W. BENNETT, M.A., B.Sc.,
*Lecturer on Botany at St. Thomas's Hospital,*

F. JEFFREY BELL, M.A.,
*Professor of Comparative Anatomy in King's College,*

AND

S. O. RIDLEY, B.A., F.L.S.,
*Of the British Museum,*

FELLOWS OF THE SOCIETY.

WILLIAMS & NORGATE,

LONDON AND EDINBURGH.

PRINTED BY WM. CLOWES AND SONS, LIMITED,] [STAMFORD STREET AND CHARING CROSS.

JOURNAL

OF THE

ROYAL MICROSCOPICAL SOCIETY.

VOL. III. No. 6.

# CONTENTS.

RECORD OF CURRENT RESEARCHES, &c.—*continued.*



BOTANY.

RECORD OF CURRENT RESEARCHES, &c.—*continued.*



MICROSCOPY, &c.


Stewart del^t. West, Newman & Co sc.

Pedicellariæ &c. of Echinostrephus molare.
Parasalenia and Stomopneustes.

# JOURNAL

OF THE

# ROYAL MICROSCOPICAL SOCIETY.

DECEMBER, 1880.


## TRANSACTIONS OF THE SOCIETY.

### XXIV.—*On some Structural Features of Echinostrephus molare, Parasalenia gratiosa, and Stomopneustes variolaris.*


By Charles Stewart, M.R.C.S., Sec. R.M.S.


(*Read* 10*th November*, 1880.)

Plate XX.

*Echinostrephus.*—This genus differs from all other Desmosticha in the form of its corona, which is broadest near the abactinal pole, with the mouth situated at the extremity of the opposite, more pointed, region. The flattened abactinal surface bearing spines far exceeding in length those of other parts.

These exceptional features give greater interest to the other points in its structure, which, in some respects, are as remarkably different from other forms as the coarser characters.

Genital glands.—These are abundantly crowded with spicula, those in the parts of the branches nearest the common duct being in the form of perforated plates, often of large size, and identical in all respects with those found in the genus *Phyllacanthus* amongst the Cidaridæ; but mixed with these, and replacing them at the tips of the branches, are numerous bihamate spicula, such as are so widely distributed amongst the Echinometradæ and Echinidæ. The greatly varied spicular forms in *Echinometra lucunter* somewhat approach to this condition, but in it the perforated plates

EXPLANATION OF PLATE XX.

Fig. 1.—Portion of genital gland of *Echinostrephus molare*.
„ 2.—Side view of jaw of gemmiform pedicellaria of *Echinostrephus*.
„ 3.—Ditto viewed from within.
„ 4.—Jaw of ophiocephalous pedicellaria of *Echinostrephus*.
„ 5.—Jaw of tridactyle pedicellaria of *Echinostrephus*.
„ 6.—Side view of jaw of gemmiform pedicellaria of *Parasalenia*.
„ 7.—Ditto viewed from within.
„ 8.—Spicula from ambulacral tube of *Parasalenia*.
„ 9.—Jaw of ophiocephalous pedicellaria of *Stomopneustes*.
„ 10.—Jaw of tridactyle pedicellaria of *Stomopneustes*.

No. 8 magnified 333 diam., the rest 75 diam.

are very different, and are apparently derived as a modification of either simple bihamate or biacerate spicula.

From each genital opening protruded a cylindrical mass of generative products, apparently surrounded and held together by a thin membrane. May this not be a provision favouring the passing of the ova or spermatozoa beyond the long spines of this region?

Pedicellariæ.—The gemmiform pedicellariæ resemble in all essential points those of *Echinometra* and *Heterocentrotus*. The jaw terminates in a long, deeply grooved fang; the groove, which is almost converted into a canal by the meeting of its margins, opening at a point near, but never at, the tip on the external or distal surface. A long, solid fang rises close to the terminal one, but nearer the base of the jaw, and usually on the right side. The expanded, wing-like portion of the jaw is deeply notched on its distal border. This character of the terminal fang, in conjunction with the two glandular masses attached to each jaw, lead me to think that these pedicellariæ have, amongst other functions, that of introducing a poison into any wound they inflict.

The gemmiform pedicellariæ are of two sizes, one about two-thirds that of the other.

There is nothing remarkable about the tridactyle pedicellariæ. The serrate borders of the prongs are widely separated, especially near the distal extremity, which is somewhat spoon-shaped; they come in contact with one another by this part, which forms about two-thirds of the entire length of the jaw. The sides of the prong are pressed in forming a crest running the whole length of its outer surface.

The ophiocephalous and trifoliate pedicellariæ are similar to those of most Echinometradæ and Echinidæ.

The ambulacral tubes have the usual bihamate spicula, but much varied in size and thickness.

*Parasalenia.*—This genus, which at first sight looks so like an ordinary *Echinometra*, differs, as has been already pointed out, in the arrangement of its pores, and in its anal plates—the latter resembling those of *Arbacia*.

Spines.—These are unlike those of any other of the Echinometradæ in showing no evidence of periodicity of growth, such as is met with in the rest of that family. The calcareous wedges, which radiate from the interior of the spine, remaining for a long time thin, and separated by a space, rather broader than themselves, occupied by the usual calcareous network. Near the surface of the spines, the wedges somewhat suddenly become much thickened, so as nearly to come in contact. Their substance is peculiar, in presenting in sections a regularly dotted character, reminding one of the markings of striped muscle. They show no peculiarity under polarized light.

Pedicellariæ.—The pedicellariæ are very scantily present. The gemmiform variety is remarkable for the complete absence of the secondary solid fang found in *Echinometra*, *Heterocentrotus*, and in some members of the genus *Strongylocentrotus.* There is a slight bulging to the right, at the base of the terminal fang, but it shows no trace of a spine. This feature is of interest, as the terminal with one basal fang is held by M. E. Perrier to be characteristic of the Echinometradæ, to which family most would, I should think, refer *Parasalenia.* The tridactyle form is exceedingly delicate, and I was unable to obtain any perfect, nor could I find any of the other varieties.

The spicula of the ambulacral tubes are unlike any that I have found in other Desmosticha. They are biacerate, and generally slightly bent in the centre. Their concave side is usually provided with two often bifid spinules. It would be interesting to know the structure of the viscera. Unfortunately my specimen was thoroughly cleaned out and dry.

*Stomopneustes.*—This genus is interesting as often showing considerable varieties in the form of the corona, which, though usually circular, is sometimes elliptical. It is remarkable also for the size and structure of the spicula of its ambulacral tubes, the spicula being equally well developed in a specimen of 1 inch diameter as in one of 4. These alone suffice to determine the genus, but as they have been already described and figured, I will not further allude to them.

Pedicellariæ.—The ophiocephalous form is very abundant, and they at once call attention from their large size. Their jaws are more powerfully toothed than in any other genus I have examined, but are most remarkable for being borne almost directly on the calcareous stem. The muscular intervening portion, usually so long, being in this case almost entirely absent, causes them to resemble at first sight the gemmiform variety. Those of the peristomal membrane are, however, of the ordinary character met with in Echini generally. I was unable to find any gemmiform pedicellariæ, though I examined many specimens with great care.

The tridactyle form is short, and varies greatly in size. They are broad, and when the jaws are closed the whole length of their finely serrate edges come in contact. The crest-like septum on the inner surface of the body of the jaw is prolonged as an irregular crest on the inner surface of the spoon-shaped prong of the jaw nearly to its tip. The great variation in the size of these pedicellariæ, and the broad, spoon-shaped character of their jaws make the smaller forms closely resemble the trifoliate variety, and lend weight to Professor Agassiz's view, that the latter are rarely stages of the former. But what I take here to be the trifoliate form, although of the same dimensions as the smallest tridactyles, show no indication of the peculiar crest described, and differ also in some other particulars.

In conclusion, I may say that it seems to me most desirable that minute, and even apparently trivial, features should be given in the descriptions of species, and that when this is more done we may find affinities between forms we should otherwise not suspect, and be enabled by the examination of even an ambulacral tube or pedicellaria, &c., to determine a species without the denudation of portions of the corona, which is sometimes not desirable.

## XXV.—*On the Diatomaceæ in the Llyn Arenig Bach Deposit.*

By Henry Stolterfoth, M.D.

(*Read 13th October*, 1880.)

Having been for some time past engaged in examining diatomaceous deposits, most of them from foreign countries, many from places one has small chance of visiting, it was with no little interest I heard of the discovery made by Mr. W. F. Lowe, of the Arenig Bach deposit. I only know of one other diatomaceous deposit in North Wales, mentioned by Smith in his 'British Diatomaceæ' as Dolgelly earth, but which I have obtained, though only in small quantities, and from some feet below the surface of the water, at a lake called Cwm Bychan, fifteen miles from Dolgelly.

In October 1879, I accompanied Mr. W. F. Lowe and a few friends to the Arenigs. We had a wet day, and lost some time in finding the lake, which lies nine miles from Bala, amidst the mountains. On reaching it, we found that it had been drained to the extent of about twelve feet below its normal level, so that about one-third of its surface was dry. The edge of the lake for about ten yards consisted of stones from the surrounding mountains, which are of igneous origin. The remainder of the uncovered surface that we were able to examine, was covered with about one foot of peat, and under this was the diatomaceous material, also about one foot thick. A small stream at the head of the lake had cut a section through the peat and diatoms, and the latter rested directly on the rocky bottom. This partial inspection of the bed of a mountain lake, more than repaid the trouble of getting to it, for not only is it something to have seen a deposit *in situ*, and to have handled and examined it in more than microscopic quantities, but it enabled me to get my specimens from different positions as naturally deposited, an important point if we are ever to determine the time during which a deposit has been forming, and the changes that may have taken place with regard to species.

This much I think we may say with regard to the Arenig deposit, that the diatoms have been collecting at the bottom of the lake ever since the last glacial period, and although the deposit was only a foot thick where we examined it, it is probable that in the centre of the lake it is much thicker.

It now remains for me to speak more particularly of the diatoms.

For the purpose of a systematic examination, I made,

1st. Gatherings of as many growing forms as I was able, in and about the lake.

2nd. I took some of the peat immediately above the deposit.

3rd. A portion of the deposit below the peat.

4th. A portion from the middle of the deposit.

5th. A portion from the lowest part of the deposit.

All these collections I kept carefully separated, and having cleaned and examined them, I have arranged them in five columns, marking the relative abundance of each species. One asterisk, marks very rare; two asterisks, rare; three asterisks, common; four asterisks, abundant.

List of Diatomaceæ from Llyn Arenig Bach.

| | 1 Recent. | 2 Peat. | 3 Top. | 4 Middle. | 5 Bottom. |
|---|---|---|---|---|---|
| Navicula | | | | | |
| nobilis Ehr. | ** | **** | **** | **** | **** |
| major W. Sm. | ** | **** | **** | **** | **** |
| divergens W. Sm. | ** | *** | *** | *** | *** |
| mesolepta Ehr. | | | ** | ** | ** |
| viridis W. Sm. | *** | *** | ** | | ** |
| gibba Ehr. | *** | *** | *** | *** | *** |
| rhomboides Ehr. | *** | **** | *** | ** | *** |
| serians Kütz. | *** | **** | **** | **** | ** |
| acuta W. Sm. | ** | | | | ** |
| firma Kütz. | * | ** | | | |
| gracillima | ** | *** | *** | ** | ** |
| cryptocephala Kütz. | ** | | | | |
| alpina W. Sm. | | ** | *** | *** | |
| lata W. Sm. | | * | | | |
| bacillaris Greg. | | ** | ** | | |
| affinis Ehr. | | ** | ** | | |
| acuminata W. Sm. | | * | ** | | |
| Tabellaria | | | | | |
| flocculosa Kütz. | **** | *** | ** | | |
| fenestrata Kütz. | | **** | | | |
| Eunotia | | | | | |
| diadema Ehr. | *** | **** | **** | ** | ** |
| tetraodon Ehr. | | ** | ** | ** | ** |
| incisa Greg. | **** | **** | **** | ** | ** |
| camelus Greg. | | * | | | |
| Epithemia | | | | | |
| alpestris W. Sm. | | | | * | * |
| Himantidium | | | | | |
| bidens Ehr. | ** | *** | ** | *** | ** |
| glacile Ehr. | *** | | ** | ** | ** |
| undulatum W. Sm. | *** | **** | *** | *** | **** |
| majus W. Sm. | ** | * | | ** | * |
| Synedra | | | | | |
| radians W. Sm. | *** | | | | |
| Cocconeis | | | | | |
| placentula Ehr. | * | | | | |
| Melosira | | | | | |
| orichalcea W. Sm. | *** | **** | *** | ** | |
| nivalis W. Sm. | ** | *** | *** | **** | **** |
| spinosa W. Sm. | | **** | *** | | |
| Cymbella | | | | | |
| scotica W. Sm. | ** | *** | *** | ** | ** |
| maculata Kütz. | ** | ** | | ** | |
| cuspidata Kütz. | | ** | | | |

| | 1 Recent. | 2 Peat. | 3 Top. | 4 Middle. | 5 Bottom. |
|---|---|---|---|---|---|
| Nitzschia | | | | | |
| tenuis W. Sm. .. .. .. | * | | | | |
| Stauroneis | | | | | |
| gracilis Ehr. .. .. .. | ** | *** | ** | ** | ** |
| anceps Ehr. .. .. .. | | * | | | |
| Surirella | | | | | |
| biseriata De Breb. .. .. | ** | **** | **** | **** | |
| splendida Kütz... .. .. | ** | * | ** | ** | **** |
| linearis W. Sm. .. .. .. | ** | ** | ** | ** | * |
| Gomphonema | | | | | |
| acuminatum Ehr. .. .. | ** | ** | ** | ** | *** |
| dichotomum Kütz. .. .. | | ** | | | ** |
| Pleurosigma | | | | | |
| lacustre W. Sm. .. .. .. | * | | | | |
| Cymatopleura | | | | | |
| solea W. Sm. .. .. .. | * | | | | |
| Odontidium | | | | | |
| mutabile W. Sm. .. .. | | **** | | | |
| Fragilaria | | | | | |
| capucina Dem. .. .. .. | | *** | | | |
| Total number of species .. | 32 | 38 | 29 | 26 | 25 |

The result arrived at from the examination of this list proves that no species has existed in the lake which is not now a living form in some place or other, while I was able to gather in a short time more living species than are to be found in any part of the deposit except the peat. The large forms of diatoms do not appear to have sunk to the bottom, but are spread uniformly throughout the deposit.

One of the variations amongst the larger forms of diatoms is marked by *Surirella biseriata* being abundant at the top and middle of the deposit, while replaced at the bottom by *Surirella splendida*, and as we go down, *Melosira nivalis* becomes more abundant, also *Gomphonema acuminatum.*

It would be a great advantage if more was known of the relative thickness of diatomaceous deposits, and the position of our specimens *in situ*, for from this we might learn something of the way in which one species replaces another.

Such an immense mass of minute forms as are collected at the bottom of Llyn Arenig Bach, point to the fact, that a long quiet age has passed since the lake was formed. How long, as yet no man can say.

This spring (1880) I have again visited the spot with the hope of making a more careful examination ; but, alas ! I found the lake again full, and all the wondrous deposit at least ten feet below the surface; and unless something goes wrong with the Bala waterworks, there is little chance that human eye will again rest on what may be termed one of the secrets of the deep.

## XXVI.—*On a New Method of Testing an Object-glass used as a Simultaneous Condensing Illuminator of brilliantly reflecting Objects such as minute Particles of Quicksilver.* By G. W. Royston-Pigott, M.A., M.D. Cantab., F.R.S., &c.

(*Read 13th November,* 1880.)

The recent advances made in object-glass illumination in America, induce me to describe some results obtained nearly two years ago. These results surprised me very much at the time, and led me to believe an infallible test had at length been discovered. Some of the phenomena are truly remarkable, and were at first extremely puzzling. They appeared to present a new order of diffraction rings of exquisite precision and beauty of arrangement.

The apparatus employed consisted of some excellent $\frac{1}{8}$ths and $\frac{1}{16}$ths. A Smith illuminator, consisting of a disk of glass placed at 45° in the optical tube, illuminated the objects by horizontal rays. The object-glass then condensed the flame upon the stage.

Mercurial globules, forced by a piston through a leather bag contained in a glass syringe, were formed extremely clean; these were then continuously smashed with a steel spring; examined; selected; and secured under a glass cover.

Viewed with dry lenses, extraordinary forms appeared. Minute, flat, circular mirrors (mirrorlets), spherical globules adhering to the upper glass, and particles adhering to the lower glass slide. The latter varied through many sizes, and each presented brilliant rings in the sharpest focal plane of remarkable appearance, totally different from anything seen before.

Diffraction rings for a *corrected glass* are almost entirely either outside or inside the focal plane. *These were in it.*

The diameter measured by micrometer (reading to $\frac{1}{100000}$ths) was nearly in every case nine-tenths of the diameter of the globule. In many an exact image of the flame presented edgeways was accurately depicted.

On the plane side of the circular little mirrorlets could be seen occasionally black points, clustering more or less, of a minuteness surpassing all previous observation: dealing an astounding blow against the microscopic dogma of a hundred thousandth of an inch being the limit of vision, " light being too coarse a thing to show anything less than half a wave-length." But more of this anon.

Another order of phenomena is differently produced. In order to preserve the mercurial particles from premature tarnishing, drops of liquid were introduced; my astonishment was great to find that the brilliant rings were now diminished to one-ninth their former size: they had just been nine-tenths the globule diameter, they were *now one-ninth!*

Selecting globules about the 100,000th of an inch—(easy of representation by separating the spider lines) under a power of 1000—by searching the illuminated field, the tiny illumination could still be caught by the best glasses I possessed. The exquisite truth of these reflections by condensing the light down upon the objects through the object-glass, forms the most thoroughly searching and infallible test of the excellence of a glass with which I am acquainted.

For some months a series of observations more and more confirmed me in this opinion.

The manipulation is somewhat delicate; the light or flame must be placed so that its distance measured by the path of the illuminating rays shall equal nearly the distance of the eye from the stage. If immersion liquids are used, those globules must be selected which appear brilliantly illumined on an intensely black ground. I have used a tin cylinder somewhat contracted at the top and perforated with a pigeon-hole aperture to project the illuminating rays horizontally.*

A transcendently fine diffracting ring of light of the most astounding attenuation may be discovered with the finest glasses, appearing much finer than the spider lines of the micrometer, the thinnest of which is the 10,000th of an inch mounted by Mr. Browning. Now what this represents on the stage when an object-glass magnifies 1000 times to the eye, I leave my friends to calculate for themselves. But many persons have agreed with me that it looked, though then enlarged a hundred times, much finer than the web in question.

Practical opticians know full well the extreme difficulty of viewing mercurial globules under very high power, and brightly illuminated by oblique rays.

This method shows true images of such surprising distinctness and incredible reduction as almost to defy adequate description.

I had the pleasure of exhibiting these appearances to Mr. Stephenson last spring, and to Mr. Curties recently.

* The polished tin entirely stops the radiation of heat upon the observer's head, which is sometimes somewhat near the illuminator.

# RECORD

OF CURRENT RESEARCHES RELATING TO

# INVERTEBRATA, CRYPTOGAMIA, MICROSCOPY, &c.*

## ZOOLOGY.

### A. GENERAL, including Embryology and Histology of the Vertebrata.

**Impregnation of the Animal Ovum.**†—Professor Schneider states that the impregnating spermatozoa disappear, either by breaking up into small pieces or by uniting to form nucleated spherules, which gradually diminish and disappear. The observations on which this statement is based were made on the eggs of *Aulostomum*, *Nephelis*, *Piscicola*, and *Mesostomum Ehrenbergii*. In *Aulostomum* and *Piscicola* there were hundreds, in *Nephelis* thousands, and in *Mesostomum* about ten entering spermatozoa. The formation of the first amphiaster has nothing to do either with their presence or their absence.

In *Aulostomum* and *Piscicola* the author made the important observation that the spermatozoa pass into the unripe egg, and are there broken up. This explains how it was that Robin took the ovaries of *Nephelis* for oospermatophores. In this form the spermatozoa are set radially, and maintain their movements for some time after their entrance into the egg.

**Influence of Light on the Development of Animals.**‡—M. Yung states, that from observations which he has been making at Naples, he is able to confirm, with regard to marine forms, the results arrived at by him in experiments on fresh-water forms. Eggs of *Loligo vulgaris*, and *Sepia officinalis*, placed in vessels containing two litres of water, and subjected to monochromatic lights of different shades, developed at unequal rates, those which were under violet or blue had their development accelerated, those under red or green retarded. Yellow most resembles white light in its effects. Such larval specimens of the Ascidian, *Ciona intestinalis*, as fixed themselves to his violet glasses grew more rapidly and gave rise to more vigorous individuals than those which fixed themselves to the other vases. Contrary to his earlier results, he finds that development, though retarded, is in fact effected under the influence of red or green glasses.

* ☞ It should be understood that the Society do not hold themselves responsible for the views of the authors of the papers, &c., referred to, nor for the manner in which those views may be expressed, the object of the Record being to present a summary of the papers *as actually published*. Objections and corrections should therefore, for the most part, be addressed to the authors.

† 'Zool. Anzeig.,' iii. (1880) p. 426.

‡ 'Comptes Rendus,' xci. (1880) p. 440. See also 'MT. Zool. Stat. Neapel,' ii. (1880) pp. 233–7.

**Origin of the Nervous System.**—The following is from Mr. F. M. Balfour's address to the Department of Anatomy and Physiology, at the recent meeting of the British Association :—

" The general features of the origin of the nervous system, which have so far been made out by means of the study of embryology, are the following :—

1. The nervous system of the higher Metazoa has been developed in the course of a long series of generations by a gradual process of differentiation of parts of the epidermis.

2. Part of the central nervous system of many forms arose as a local collection of nerve-cells in the epidermis, in the neighbourhood of rudimentary organs of vision.

3. Ganglion-cells have been evolved from simple epithelial cells of the epidermis.

4. The primitive nerves were outgrowths of the original ganglion-cells; and the nerves of the higher forms are formed as outgrowths of the central nervous system.

The points on which embryology has *not* yet thrown a satisfactory light are :—

1. The steps by which the protoplasmic processes, from the primitive epidermic cells, became united together so as to form a network of nerve-fibres, placing the various parts of the body in nervous communication.

2. The process by which nerves became connected with muscles, so that a stimulus received by a nerve-cell could be communicated to and cause a contraction in a muscle.

Recent investigations on the anatomy of the Cœlenterata, especially of jelly-fish and sea-anemones, have thrown some light on these points, although there is left much that is still obscure.

In this country Mr. Romanes has conducted some interesting physiological experiments on these forms; and Professor Schäfer has made some important histological investigations upon them. In Germany a series of interesting researches have also been made on them by Professors Kleinenberg, Claus, and Eimer, and more especially by the brothers Hertwig, of Jena. Careful histological investigations, especially those of the last-named authors, have made us acquainted with the forms of some very primitive types of nervous system. In the common sea-anemones there are, for instance, no organs of special sense, and no definite central nervous system. There are, however, scattered throughout the skin, and also throughout the lining of the digestive tract, a number of specially modified epithelial cells, which are no doubt delicate organs of sense. They are provided at their free extremity with a long hair, and are prolonged on their inner side into a fine process, which penetrates the deeper part of the epithelial layer of the skin or digestive wall. They eventually join a fine network of protoplasmic fibres, which forms a special layer immediately within the epithelium. The fibres of this network are no doubt essentially nervous. In addition to fibres there are, moreover, present in the network, cells of the same character as the multipolar ganglion-cells in the nervous system of Vertebrates, and some of these cells are characterized by sending a process into the superjacent epithelium. Such cells are obviously epithelial cells in the act of becoming nerve-cells; and it is probable that the nerve-cells are, in fact, sense-cells which have travelled inwards and lost their epithelial character. There is every reason to think that the network just described is not only continuous with the sense-cells in the epithelium, but that it is also continuous with epithelial cells which are provided with muscular prolongations. The nervous system thus consists of a network of protoplasmic fibres, continuous on the one hand with sense-cells in the epithelium, and on the other with muscular cells. The nervous network is generally distributed both beneath the epithelium of the skin and that of the digestive tract, but is especially concentrated in the disk-like region between the mouth and tentacles.

The above observations have thrown a very clear light on the characters of the nervous system at an early stage of its evolution, but they leave unanswered the questions how the nervous network first arose, and how its fibres became continuous with muscles.

It is probable that the nervous network took its origin from processes of the sense-cells. The processes of the different cells probably first met and then fused together, and becoming more arborescent, finally gave rise to a complicated network.

The connection between this network and the muscular cells also probably took place by a process of contact and fusion.

Epithelial cells with muscular processes were discovered by Kleinenberg before epithelial cells with nervous processes were known, and he suggested that the epithelial part of such cells was a sense-organ, and that the connecting part between this and the contractile processes was a rudimentary nerve. This ingenious theory explained completely the fact of nerves being continuous with muscles; but on the further discoveries being made just described, it became obvious that this theory would have to be abandoned, and that some other explanation would have to be given of the continuity between nerves and muscles. The hypothetical explanation just offered is that of fusion.

It seems very probable that many of the epithelial cells were originally provided with processes, the protoplasm of which, like that of the Protozoa, carried on the functions of nerves and muscles at the same time, and that these processes united amongst themselves into a network. By a process of differentiation parts of this network may have become specially contractile, and other parts may have lost their contractility and become solely nervous. In this way the connection between nerves and muscles might be explained, and this hypothesis fits in very well with the condition of the neuro-muscular system as we find it in the Cœlenterata.

The nervous system of the higher Metazoa appears then to have originated from a differentiation of some of the superficial epithelial cells of the body, though it is possible that some parts of the system may have been formed by a differentiation of the alimentary epithelium. The cells of the epithelium were most likely at the same time contractile and sensory, and the differentiation of the nervous system may very probably have commenced, in the first instance, from a specialization in the function of part of a network formed of neuro-muscular prolongations of epithelial cells. A simultaneous differentiation of other parts of the network into muscular fibres may have led to the continuity at present obtaining between nerves and muscles.

Local differentiations of the nervous network, which was no doubt distributed over the whole body, took place on the formation of organs of special sense, and such differentiations gave rise to the formation of a central nervous system. The central nervous system was at first continuous with the epidermis, but became separated from it, and travelled inwards. Ganglion-cells took their origin from sensory epithelial cells provided with prolongations continuous with the nervous network. Such epithelial cells gradually lost their epithelial character, and finally became completely detached from the epidermis.

Nerves, such as we find them in the higher types, originated from special differentiations of the nervous network, radiating from the parts of the central nervous system."

With regard to organs of special sense, Mr. Balfour (in an earlier part of his address) pointed out that it might have been anticipated *à priori* that organs of special sense would only appear in animals provided with a well-developed central nervous system. This, however, is not the case. Special cells with long delicate hairs, which are undoubtedly highly sensitive structures, are present in animals in which as yet nothing has been found which could be called a central nervous system; and there is every reason to think that the organs of special sense originated *pari passu* with the central nervous system. It is probable that in the simplest organisms the whole body is sensitive to light, but that with the appearance of pigment-cells in certain parts of the body, the sensitiveness to light became localized to the areas where the pigment-cells were present. Since, however, it was necessary that stimuli received by such organs should be communicated to other parts of the body, some of the epidermic cells in the neighbourhood of the pigment-spots, which were at first only sensitive, in the same manner as other cells of the epidermis, became gradually differentiated into special nerve-cells.

As to the details of this differentiation, embryology does not as yet throw any great light; but from the study of comparative anatomy there are grounds for thinking that it was somewhat as follows:—Cells placed on the surface sent protoplasmic processes of a nervous nature inwards, which came into connection with nervous processes from similar cells placed in other parts of the body. The cells with such processes then became removed from the surface, forming a deep layer of the epidermis below the sensitive cells of the organ of vision. With these cells they remained connected by protoplasmic filaments, and thus they came to form a thickening of the epidermis underneath the organ of vision, the cells of which received their stimuli from those of the organ of vision, and transmitted the stimuli so received to other parts of the body. Such a thickening would obviously be the rudiment of a central nervous system, and it is easy to see by what steps it might become gradually larger and more important, and might gradually travel inwards, remaining connected with the sense-organ at the surface by protoplasmic filaments, which would then constitute nerves. The rudimentary eye would at first merely consist partly of cells sensitive to light, and partly of optical structures constituting the lens, which would throw an image of external objects upon it, and so convert the whole structure into a true organ of vision. It has thus come about that, in the development of the individual, the retina or sensitive part of the eye is first formed in connection with the central nervous system, while the lenses of the eye are independently evolved from the epidermis at a later period.

**Terminations of Nerves in the Epidermis.***—Professor Ranvier, in a paper on this subject, mentions an improvement which he has devised in the method of using chloride of gold for investigations on the ultimate nerve-endings in tissues, the process of Loewit, though a great improvement on that of Cohnheim, having disadvantages.

In the first place Professor Ranvier placed the tissues with the nerve terminations two to four hours in a mixture of chloride of gold and formic acid which had been boiled and then cooled. After removal and washing, the reduction of the gold is effected either by the action of daylight in slightly acidified water, or in the dark in a solution of formic acid. By this method the terminations of the nerves in muscles appear continuously arborescent instead of being frequently interrupted as when Loewit's process is employed. At the same time they contain some irregularities. For this reason Professor Ranvier says it became necessary to invent a fresh process, and he attempted to replace formic acid by one which would not have an equally deleterious effect on delicate elements, and he believes he has found it in lemon-juice. This, although altering nervous tissues by its protracted action, yet preserves their form sufficiently long for it not to be altered in the time requisite to procure the whole effect of the chloride of gold. Preparations of the white or red muscles of the rabbit treated successively with lemon-juice and chloride of gold, preserve the nerve terminations not only continuously arborescent but also remarkably regular.

This process was adopted by Professor Ranvier in his investigation of the nerve terminations in the epidermis in general (employing the snout of the pig, the nose of the mole, and the skin of the human finger), and after a brief statement of the results, he says "the theory, or rather the hypothesis, which I propose is founded on the facts which I have just briefly expounded. The nerves which enter the epidermis, whatever may be the form or extent of their ramifications, are subject to a continuous evolution. They grow while at the same time their terminations undergo a gradual degeneration; this degeneration leads to the formation of granules of nervous substance, which become perfectly free and are soon transported into the inert layers of the epidermis."

**Minute Structure of Smooth Muscular Fibres.**†—The latest researches of Professor Engelmann have led him to the conclusion that,

* 'Quart. Journ. Micr. Sci.,' xx. (1880) pp. 456–8, plate xxxvi.

† 'Rev. Internat. Sci.,' vi. (1880) p. 182.

notwithstanding the generally received opinion, the smooth muscular fibres are made up of fibrillæ. The parts which have been made the subject of his investigations are the stomach, intestinal canal, bladder, and arteries of rabbits, pigeons, tritons, and frogs, together with various organs from invertebrate animals.

The size of the fibrillæ appears to be fairly constant, and their width to be very much that of the fibrillæ of striated muscular fibre. They are generally cylindrical in form and non-ramified; in some abnormal cases they exhibit varicosities. They are always optically homogeneous, and very markedly exhibit double refraction. Each fibrilla is surrounded by a layer of homogeneous matter, not doubly refractive, and, during life, scarcely measurable. It would seem to be soft and more or less coherent. In most cases the fibrils are set at equal distances from one another, and are not grouped into fasciculi; they have, as a rule, a direction parallel to that of the long axis of the muscle cells. There are, however, certain very remarkable exceptions to this rule to be observed in many Invertebrata. In some the fibrils exhibit a helicoid arrangement around the longitudinal axis of the cells. Observations on this point can easily be made on the anterior adductor muscles of *Anodon*, and it will then be seen that the angle which these fibrils make with the axis depends largely on the state of contraction of the muscle. When in a state of contraction they exhibit the double striation which was first observed by Schwalbe. The author shows that this is partly due to an optical illusion, and in part to the state of compression of the fibrils. It is not, consequently, correct to regard these muscles as affording any intermediation between smooth and striated muscular elements.

A very remarkable fact has also been noted by Engelmann—the optic axis of the doubly refractive fibrils does not coincide with their longitudinal axis, but with that of the cell.

In conclusion, attention is directed to the generalization that there is a unity in the structure of the different contractile elements; these are, strictly, always fibrils. It is demonstrable already in the case of muscles, whether "smooth" or "striated," as well as in that of vibratile cilia and of spermatozoa. Further observations will probably show it to be true of many forms of protoplasm.

Changes which Starch undergoes in the Animal Organism.*—Herr H. E. Bimmermann, after referring to the statement of Musculus and Gruber, that starch, by the action of diastase or acids, yields soluble starch, maltose, grape-sugar, and three forms of dextrin, named respectively $\alpha$, $\beta$, and $\gamma$ achroodextrin, which are variously affected by ferments, states that while maltose and grape-sugar are produced by the action of saliva on starch, glycogen, whether obtained on a diet of grape-sugar or albuminoids, when treated in the same manner, yields larger quantities of maltose and grape-sugar and a reducible dextrin.

Sachsse's method of estimating sugar by mercuric iodide was used, as it was found difficult to determine the end of the reaction with Fehling's solution. The substances were injected into the jugular

* 'Pflüger's Archiv,' xx. (1880) pp. 201–10. See 'Journ. Chem. Soc.,' Abstr. xxxviii. (1880) p. 677.

vein of a rabbit, and the urine subsequently examined, with the following results:—

Maltose is partly converted in the blood into grape-sugar, and partly passes out unchanged. Soluble starch yields dextrin and grape-sugar. Achroodextrin ($\alpha$) suffers only partial change, grape-sugar and maltose being found in the urine, together with dextrin. Achroodextrin ($\beta$) yields a similar result. Achroodextrin ($\gamma$) yielded no sugar.

Generally, the results tend to show that the changes which starch undergoes in the body are similar to those which occur when it is submitted to the action of diastase outside it.

## B. INVERTEBRATA.

**Deep-water Fauna of the Swiss Lakes.***—Dr. Asper gives a brief account of his investigations into the fauna of eleven of the Swiss lakes.

That of the Lake of Zurich would appear to be very rich. The Mollusca are represented by various genera, and those delicate Cyclads—the Pisidia—are always present. The larvæ of Diptera were also numerous. Living in small tubes formed from the slime, they are either colourless or of an intense yellow or red colour; and they chiefly belong to the genera *Chironomus* and *Tanypus*. Acarida were nowhere completely absent. Vermes were richly represented, and chiefly by species of *Lumbriculus* and *Sænuris*. Of the latter genus great quantities were observed. There was also a colourless *Hydra*. In the Lake of Lucerne seventy specimens of what appears to be *Asellus Foreli* were taken at one dredging. Here, again, Lumbriculids and Dipterous larvæ were very abundant. In the Lake of Sils (Engadine)—to omit many points of interest in other lakes—the Hydroids appear to be especially remarkable. A new species is described and figured by the author under the name of *Hydra rhætica*. Of a bright red colour, and often as much as $1\frac{1}{2}$ cm. in size, it gives indications of forming buds which remain permanently attached to it, and so give rise to a colony. The male and female individuals can be easily distinguished. The fauna of this lake was very rich in individuals, though comparatively poor in species.

**Dredgings in the Bay of Biscay.**†—The following are some of the more important results to which M. A. Milne-Edwards directs attention.

The Crustacea were, he says, extremely interesting; not one of the specimens dredged is also littoral in habitat, and it seems as though there were two faunæ placed one above the other, and not mixing. He forms a new genus—*Scyramathia*—to contain *Amathia Carpenteri* and *Scyra umbonata*; a crab with phosphorescent eyes was found at various depths between 700 m. and 1300 m. (*Geryon tridens*); this has been already seen in the Norwegian seas. *Munida tenuimana*, with large and phosphorescent eyes was not rare. *Gnathophausia zoea*, which

* 'Zool. Anzeig.,' iii. (1880) pp. 130, 200.

† 'Comptes Rendus,' xci. (1880) p. 355.

has only as yet been collected by the 'Challenger' (off the Azores and near Brazil) was also met with.

Most of the Mollusca belong to the deep-sea fauna of the North Atlantic and of the Arctic Seas; among the Mediterranean forms, there were some which as yet have only been found in the fossil state. The similarity of the deep-sea fauna at different latitudes is very strikingly shown by this collection. Pteropoda were taken from all depths; indications of Heteropoda were not absent. A short list of the more important Mollusca obtained is given by M. Milne-Edwards in a foot-note.*

Chætopod worms were abundant at all the stations; a species of the remarkable *Chætoderma* was also taken; two or three new genera of Gephyrea were met with, and several of the forms had a resemblance to the arctic species.

A new species of *Edwardsia* (or *Hyanthus*), a beautiful red *Adamsia*, a large *Bunodes*, and a new species of *Flabellum* represent the most striking Zoantharia; the Alcyonaria are reported to be very remarkable, and among them was a specimen of the rare *Umbellularia*.

The Echinodermata appear to form the most valuable part of the collection; there is a new species of *Phormosoma*, which is to be distinguished from *P. placenta* by the ornamentation of the plates, and by its large spines on the oral surface; *Pourtalesia Jeffreysii*, two new and remarkable Spatangoids make up the chief Echinid gains. The Asterida were all interesting and rare; but above all we have to note the capture of *Brisinga coronata*, which was taken at several stations. Among the Ophiurids, which were abundant, there was found one which, not described, is said to be probably the representative of an absolutely new type. There are some new and fine species of Holothurioida. Among the Crinoids we find only two examples of an *Antedon*, allied to *A. Sarsi* of the Northern Seas.

*Hyalonema*, *Holtenca*, *Farrea*, &c., were among the Siliceous Sponges.

Large specimens of *Orbitolites tenuissima* and a magnificent series of arenaceous forms are to be noted among the Foraminifera.

In some cases the dredge descended to 3000 metres, and, in addition to the zoological collections, there have been made observations of very considerable importance on the hydrographical relations of the sea-bottom of this region.

**Deep Dredgings in the Lake of Tiberias.**†—The Invertebrata obtained by M. Lortet in these dredgings include ten species of Mollusca, of which three are new to science. These are named by M. Locard, *Unio Lorteti*, *U. pietri*, *U. Maris Galilæi*. The other species are *Unio terminàlis* and *tigridis*, *Cyrena fluminalis*, *Neritina jordani*, *Melania tuberculata*, *Melanopsis præmorsa* and *costata*. The three latter shells give the fauna a marine appearance; and it is to be considered as a transition-fauna between salt and fresh water, the lake having probably been originally salt, and subsequently altered

* See also the lists of Dr. J. Gwyn Jeffreys, 'Ann. and Mag. Nat. Hist.,' vi. (1880), pp. 315 and 374.

† 'Comptes Rendus,' xci. (1880) p. 500.

by the passage of the Jordan waters through it. Near the shore were found a small shrimp, and the crab *Telphusa fluviatilis*. A very fine volcanic mud from the greatest depths contained diatoms, foraminifera, &c. No alga was brought up.

The *Unio* shells at the depth of 250 metres were curiously softened, and resembled in condition the fossils of some of the Tertiary strata of the middle of France; this is probably chiefly due to pressure.

**Fresh-water Microscopic Organisms.***—Professor Maggi has published a catalogue of the Rotifera of Valcovia, containing fourteen genera, and eighteen species.

He also gives a list of the fresh-water Rhizopoda of Lombardy, and has come to the conclusion that *Amphizonella flava* is not identical with *Pseudochlamys patella*, but that it is a developmental stage of some unknown form. He has investigated the plastids found in ciliated Infusoria, and, especially, those which are found in the nuclei of the Oxytricha. When these organisms are treated with a two-per-cent. solution of bichromate of potash, dark granulations are to be observed in the parenchyma of the body, and a black reticulum is also to be made out in the nuclei.

## Mollusca.

**Excretory System of the Cephalopoda.**†— One important point to which Dr. Vigelius has especially given his attention in this paper is the homology between the renal organs of the cephalopodous and of the other Mollusca, but unfortunately with no certain result.‡

Commencing with the *Dibranchiata Decapoda*, he finds in all a general agreement in the essential points; there is but one renal sac, which lies between the gills and communicates with the pallial cavity by two symmetrical efferent ducts or orifices. Various veins, which carry venous blood to the gills, also pass into the renal sac, and enter into close connection with its walls; they are the bearers of the so-called venous appendages. In the upper or dorsal portion of the sac there are two bile-ducts which finally unite and pass their contents into a gastric cæcum. The sac itself is laterally connected by two orifices with a large, and otherwise closed cavity (viscero-pericardial cavity) which contains the arterial heart, the median portion of the branchial veins, the branchial hearts with their appendages, certain organs of the digestive system, and, finally, the generative gland.

In place of a short account of the different forms examined, a somewhat more detailed history of one form—the common *Sepia officinalis*—will be preferable. Some way behind the anus there is to be noticed on either side a cylindrical tubule, which projects freely into the branchial cavity; there the efferent ducts of the renal sac have thick muscular walls, and their fine lumen opens by a small, rounded, terminal pore; they are separated from one another by the rectum and by the duct of the ink-bag. These ducts divide the

* 'Rev. Sci. Nat.,' ii. (1880) p. 242.

† 'Niederl. Arch. Zool.,' v. (1880) pp. 115–84. (2 plates.)

‡ He always speaks of that part of the body which contains the branchial cavity as being ventral in position.

ventral portion of the renal sac into two lateral regions; the right one is elongated in form, and save for its urethral opening would appear to be closed. It extends backwards as far as the aboral surface of the branchial heart, while anteriorly it gradually diminishes in size, as it passes into the right ureter. The right ventral portion is almost completely filled up by the numerous appendages attached to the veins which traverse it; these are, when fresh, more or less transparent and hyaline, and of a spongy texture, they vary in size, and in spirit specimens often form a single mass.

The author then enters into a detailed account of the veins of this (right ventral) region. In it, as in the left ventral portion, there are (1) a branch of the vena cava, (2) the lateral pallial vein, and (3) the vena abdominalis; and these are attached to the dorsal and lateral walls. But in the left half there is not, as there is in the right, any vein for the ink-bag, or any vena genitalis; but instead of these there is a mesenteric vein. The left half is, moreover, not so completely closed as the right is, for there is a pore by means of which it is connected with the dorsal half of the renal sac. There are, further, communications (two) between the two ventral portions. The superior or dorsal portion of the sac is a spacious cavity which, save for the already-mentioned ventral pores, is completely closed; but it does not lie directly on the ventral half, for it is separated by a portion of the body-cavity, of a considerable size. Various digestive organs are to be found within it; there is the spirally coiled cæcum, and the two gall-ducts, with their peculiar appendages, to which the name of pancreas has been applied. The intervening body-cavity, already mentioned, is connected with the sac by two orifices; near the base of each ureter there is, on the inner wall of the sac, an orifice which leads into a canal; this canal widens into a cavity, in which there is contained the asymmetrically placed arterial heart; the hinder portion of this "pericardial cavity" is occupied inferiorly by the ink-bag and the generative organs, and is limited superiorly by the dorsal portion of the renal sac; its right side is almost completely filled up by the stomach. This then may be known as the viscero-pericardial cavity.

Within the renal sac there are to be found reddish spheres with a sharp contour, and not rarely surrounded by a colourless ring; there are also rhombic crystals, sometimes reddish in colour, and varying much in size; in form they resemble crystals of uric acid, and they seem undoubtedly to be products of excretion. Other spheres are also to be seen in the freshly killed animal, which are of a pale green colour, and generally exhibit a concentric structure; it is possible that these are developmental stages of the true excretion-spheres. The wall of the sac is made up of fibrillar connective tissue, with a few muscular bands. The inner surface is invested by a unilaminate mosaic of epithelial cells, flattened or polygonal in form, and provided with large nuclei. In the ureter there is a cylindrical epithelium, which gives rise to a fine cuticle; on the opposite side of the basal membrane there are a number of irregularly arranged, circular and longitudinal muscular fibres. The venous appendages appear to have a solely excretory function; each of them consists of a branching system of veins, giving off a number of finer vessels, which extend to the periphery, but these do not appear to exhibit any regular arrangement.

In the *Octopoda Dibranchiata* we again find two renal sacs, which communicate with the exterior by two ureters; but the ureters are papilliform. Veins traverse the sac, as in the Decapoda, and on their course they also develop venous appendages (excretory organs); each renal sac communicates with a system of canals which in the female leads to the generative gland, and in the male to the investing sac. In the female the canal-system is symmetrically developed, but in the male, owing to the excentric position of the generative organs, it is asymmetrical. The author's most important example in this group is *Octopus macropus.*

For the *Tetrabranchiata* the author had unfortunately to content himself with a single example; he was chiefly able to concern himself with the venous appendages, and he finds that in histological structure they have a very close resemblance to the same organs in the Dibranchiata, and the same is true as to the four renal sacs.

If then the venous appendages of all the Cephalopoda are formed on the same type it will be well to sum up their real characters; they are closed branching systems, arising from the veins, of a secretory function; this is shown not only by their structure and by their relations to the veins but by the presence in their lumina of definite bodies, which are obviously excretory products; these last are always given off in a solid condition; and the fluid present appears to be only the medium by which they are conveyed to the exterior. The agreement between the Tetrabranchiata and Dibranchiata does not end here; in both, the pericardium is provided with slits, and though those of the Decapoda do not now open into the pallial cavity, it is very probable that they did so primarily. The branchial hearts do indeed present rather more difficulties, for in *Nautilus* the branchial hearts with their appendages are not to be found in any viscero-pericardiac cavity, but this may be explained by supposing that these organs were in the Dibranchiata primitively separated off from the branchial arteries, and became locally developed to their present size. In that artery it is possible to distinguish a longer and wider portion, from one which is narrower and shorter; in the Dibranchiata these are separated by the branchial heart, while in *Nautilus* the follicular appendage is developed at their point of junction, and it was at this point that the venous heart of the Dibranchiata was developed. If this supposition be accepted, it easily follows that in all probability the appendage of the venous heart was developed from the follicular appendage; and there is still a great morphological similarity between the two organs.

The author is not inclined to agree with Hancock in regarding the renal chamber of the Nudibranchs as being homologous with the renal chamber proper of the Cephalopod; and he believes that the English zoologist has been led astray by not taking into account the organization of *Nautilus;* nor does he seem to agree with the views put out by Gegenbaur; and in short he comes to the conclusion that we have not as yet a sufficient body of facts to justify us in arriving at any definite determination of what organs in the other Mollusca are homologous to the renal organs of the Cephalopoda.

**Influence of Acids and Alkalies on Cephalopods.***— M. Yung finds himself able to confirm, in these animals, most of the results obtained by M. Richet when operating on Crustacea.†

The Cephalopoda are extremely sensitive to the action of mineral acids; with a slight dose the respiratory movements are accelerated; four specimens of *Eledone moschata*, respiring twenty-four to twenty-six times a minute, gave after five minutes in 2 litres of water containing ·5 cc. of sulphuric, nitric, hydrochloric, and oxalic acids, respectively, fifty-six, forty-two, thirty-six, and thirty respirations a minute. A double dose in the case of all but oxalic acid had a toxic effect, but sulphuric acid was the slowest in its results.

The alkalies may be ranged in the following order of toxicity:— ammonia, potash, sodium, calcium, baryta. The first is extremely rapid; with a dose of one per thousand, it kills almost at once; the respiratory movements are, at first, accelerated, and after having reached a maximum which varies with the agent employed, they gradually diminish.

**"Liver" of the Gastropoda.**‡—Dr. Barfurth is of opinion that this organ is a hepato-pancreas; his most important observations appear to have been on *Arion empiricorum*, and in it he recognizes three kinds of cells as composing the gland in question.

When fresh portions of the organ are suitably treated with osmic acid, some of the cells rapidly become deeply tinged of a black colour; these are regarded as the preparers of the hepatic ferment; their contents are ordinarily large spheres, of a yellow or brown colour, in the fresh state; the cells are generally elongate, and often spherical. The second set of cells are the true hepatic cells, with the nucleus placed in their basal portion; elongated in form, they are considerably thickened near the lumen of the follicle; their contents chiefly consist of small, spherical, or irregularly shaped granules, which only blacken after some hours' exposure to the influence of osmic acid; the secretion of these cells is soluble in alcohol or ether, contrary to what happens with the ferment-cells. The third form of cell is filled with highly refractive colourless granules which consist in most cases of carbonate of lime, allied with some organic substance; but their further characters have still to be investigated.

Differences seem to obtain between the aquatic and terrestrial Gastropods in their behaviour to chemical reagents; the livers of the former harden much more slowly in absolute alcohol and osmic acid, and their ferment-cells do not blacken so quickly; while the calcareous cells may be absent, scarce, or replaced by small crystals of what is apparently oxalate of calcium.

* 'Comptes Rendus,' xci. (1880) p. 439.
† See this Journal, *ante*, p. 628.
‡ 'Zool. Anzeig.,' iii. (1880) p. 499.

**Striated Muscles in the Monomyarian Acephalous Mollusca.***— Although the existence of such muscles was affirmed by Reichert as early as 1842, and by subsequent authors, in certain Cephalopoda, Acephala, and Gasteropoda, on the ground of a transverse striation which was noticed, yet M. Blanchard has determined these facts to have been wrongly interpreted: such striation in the cases advanced was either due to the contracted state of the fibres, or to a special arrangement of the intracellular or interfibrillar granular matter of the muscles.

On the other hand, their existence in certain Mollusca is now established by his own investigations, viz. in the *Pectinidæ* alone.

In a *Pecten* (*P. jacobeus*, e. g.) the adductor muscle is compound; a smaller, white, shining division is separated from the rest of the mass by a membrane proceeding from the sheath, and is formed of smooth fibres; the larger mass, which consists of striated fibres, is dull grey in colour.

This tissue, like the muscle of the wing of *Hydrophilus*, is formed of a number of very delicate parallel fibrillæ not united by sarcolemma, but they are not interspersed with granular matter, as in the muscle of the insects' wing. Each fibril extends from one valve to the other. Besides a coarse transverse striation, an extremely fine one is distinguishable by a power of 500 to 600 diameters; here the "thick disks" seen in the wing muscle of *Hydrophilus* alternate with "clear spaces," which here too are crossed by "thin disks"; by treatment with chromic acid or with dilute alcohol the "clear spaces" are also seen in the thick disks, in some fibrils here also the thick and thin disks colour strongly with carmine, and especially with hæmatoxylin. Polarized light exhibits the "disks" as doubly, and the clear spaces as singly, refractive, as in Vertebrata. The muscle of *Pecten* is however distinguished more evidently from that of *Hydrophilus* by the occurrence on each fibril of a large elongated nucleus which projects from the surface, colours strongly with carmine, and contains granular protoplasm. The mean diameter of the fibril is ·01 mm., varying to ·02 mm.; the mean length of the nucleus is from ·01 to ·012 mm., its breadth from ·004 to ·005.

If the adductor muscle of *Pecten* is homologous, as M. Lacaze-Duthiers has declared, with the posterior adductor of the *Dimyaria*, one would expect to find striated fibres in this muscle also; but they are absent from this and all other parts of *Mytilus edulis*, *Anodonta*, and *Unio* hitherto investigated. The compound nature of the muscle in the former case points rather to the conclusion arrived at by Gegenbaur, that it consists of the two originally distinct adductors.

As an object for histological study this muscle is preferable to that of the *Hydrophilus* wing, as it is easy to fix it either in the relaxed or contracted state; the fibres are larger and more easily isolated, and the granular substance which interferes with the preparation in the latter case is here absent. Although the tissue has been vainly sought for in the Gasteropods and in various races of the oyster, yet in the latter form the adductor presents very different characters in its two halves, so that it gives encouragement to further investigation.

* 'Rev. Internat. Sci.,' v. (1880) p. 356.

**Green Colour of Oysters.***—In 1877,† mention was made of the fact that the green colour observed in oysters, in certain localities, is caused by a variety of *Navicula*, to which the name *N. ostrearia* has been given. Further particulars of experiments made by M. Puységur, at Sissable, are not without interest.‡

"The green slime was collected by lightly scraping the margin of one of the 'clears' with a spoon, and was put in flasks, shaken for a moment, and then allowed to settle, so as to get rid of the mud, some admixture of which is inevitable. The coloured fluid, containing little or nothing besides diatoms, was then poured off into other flasks. Care and some little dexterity are requisite, as if there is too much silt, or too large a quantity of water, which is generally the case when the task is intrusted to a subordinate, it is sometimes next to impossible to concentrate the fluid enough to show the results with the desired plainness.

Returning home, we poured the fluid into soup-plates set on a table before a window. The diatoms speedily settled on the sides and bottoms of the plates, coating them with a green slime, the thickness and tint of which varied with the proportion of diatoms present. In each plate, according to its size, we put three to six perfectly white oysters, which had never been in the 'clears,' and the shells of which had previously been washed and brushed clean. In similar plates like numbers of the same oysters were laid in ordinary sea-water. Twenty-six hours after the commencement of the experiment the oysters in the water charged with diatoms had all acquired a marked greenish hue; the other oysters remained unaltered. The experiment was repeated many times with identically the same results. The green colour in the oysters was found to be more decided in proportion as the water was more highly charged with diatoms. In the course of the experiments the shell of one of the oysters was perforated, so as to lay bare the mantle. After the oyster had turned green, it was laid in ordinary sea-water for a few days, when the greenness disappeared altogether. It reappeared when the oyster was replaced in fresh water containing *Navicula ostrearia.*

In the course of the experiments it was observed that by the opening and closing of their valves the oysters induced currents in the water, by means of which they drew towards them, and surrounded themselves with, the particles of matter suspended therein. The existence and direction of these currents were shown by the disappearance of the slime and the consequent laying bare of the sides and bottoms of the plates, the diatoms remaining only at points out of reach of the currents. Directed towards the buccal aperture by the cilia with which the branchiæ are provided, the *Naviculæ* enter the stomach of the mollusc, and there part with their nutritive constituents. The yellow chlorophyll is digested and decomposed; the soluble colouring matter passes direct into the blood, to which it imparts its colour. Thus it happens that the most vesicular portions of the structure, as the branchiæ, are the most highly coloured.

Examination of the digestive tubes of the oysters experimented

* 'Nature,' xxii. (1880) p. 519. † Ibid., xvi. (1877) p. 397.

‡ 'Revue maritime et coloniale,' February 1880.

upon proved the fact of the absorption of the diatoms. The stomachs, intestines, and fæces were strewed with loricæ of *Naviculæ*. The loricæ, being siliceous, are not affected by the digestive juices, and it would seem extraordinary that with so tenacious a covering their contents should be evolved, were it not for the knowledge of the fact that the covering is not continuous, the line of suture separating the valves composing the frustule being scarcely silicified at all."

It would therefore appear to be established beyond dispute that the green hue in oysters is due exclusively to their absorption of certain *Naviculæ* contained in the circumambient water. The facts are in perfect keeping with the observations of growers, that heavy rains (which increase the supply of fresh water) cause the disappearance of the green from the "clears," while, on the other hand, dry north-east gales, which greatly increase the saturation of the water, bring it, as it is called, "into condition."

Two points of special interest in connection with the subject remain for future investigation. These are :—

1. Does the *Navicula* in question remain all the year in the waters where it is found in winter ?

2. Is the coloration of the beds accidental or temporary ? In other words, Does this alga disappear from the reservoirs when the water changes its colour, or does it become itself discoloured for a time ?

**Neomenia gorgonophilus.***—Dr. A. Kowalevsky has described the structure of this new species.

About 2 inches long, it lives parasitically on Gorgonias, creeping about after the manner of a Nemertine. On the lower surface of the body there extends, from the mouth to the anus, an exceedingly delicate ciliated foot. The gelatinous investment of the rest of the body consists of (1) a gelatinous substance ; (2) calcareous spicules in a horny basal layer, and (3) epithelial cells of two forms ; in one the cells are short, and in the other elongated. Subjacent to the integument there is a muscular layer, which is especially well developed in the region of the foot, and in this region there are not only longitudinal, but also transversely disposed muscles. The enteric tract is straight, and appears to open posteriorly into a muscular cloaca ; into this there also open the duct of the ovary, and two tubular glands, which are very probably the testicles. There is a supra-œsophageal ganglion, whence arise four longitudinal nerve-trunks, which extend through the whole length of the body ; two are larger and median (pedal) and two smaller and lateral. They are regarded as corresponding to the pedal and branchial trunks of the Chitons. The dorsal vessel, which is best seen in young examples, has a considerable enlargement anteriorly. As to the organs of secretion, the author finds, at the sides of the digestive canal, a large number of cells, which fill up the whole space between it and the walls of the body, and contain rounded concretions, similar to those found in the molluscan organ of Bojanus. Above the dorsal vessel, and on either side of it, there lies the paired ovary.

* 'Zool. Anzeig.,' iii. (1880) p. 190.

The organ which has been regarded as the testicle lies below the enteric tract; it commences as an unpaired tube, but soon bifurcates.

### Molluscoida.

**Australian Polyzoa.***—The Rev. J. E. Tenison-Woods gives a description and figure of an *Amathia* from Australia, which he considers new, and calls *A. tortuosa*, and takes the opportunity of reviewing the family. This species is, however, common in the Mediterranean, and is no doubt the *Serialaria semiconvoluta* of authors on the Mediterranean fauna, which has, however, as yet been but imperfectly and not always correctly described. The fact of the cells being biserial has led one Australian author to form a new genus for the species, but the growth is the same with the Mediterranean and several other species, which, however, varies much in the length of the internodes, so that one European writer has, in manuscript, called a variety similar to the Australian one, *Serialaria distans*.

Mr. Woods has not given the size of his forms, which is important, as we believe the variety in the Australian seas has a much larger growth than the Mediterranean one. Although this paper is founded on a mistake, Mr Woods has put together a great deal of information on the family which will be of use to workers in Australia, where the literature is not so easily obtainable.

Mr. Woods very wisely gives a figure of what he considered a new species, and it would be a great benefit if other authors would follow him in this, for several Australian and New Zealand workers have lately been giving descriptions without plates, and thus names have been created, to a large extent, of forms which the descriptions (in not a few cases imperfect) will not enable others to recognize.

**Fossil Catenicellæ from the (Australian) Miocene.**†—Mr. J. B. Wilson reports the discovery of *Catenicellæ* in the Miocene Tertiary beds near Geelong, on which Mr. Busk has favoured us with the following note:—

"The occurrence of Catenicellidæ in the fossil state, and so far back as the Miocene epoch, if that be really the age of the beds, is an important and interesting fact. In 1865 the Rev. J. E. Tenison-Woods, in a paper on the fossil Polyzoa of the same district, laid particular stress on the circumstance that the marine fauna of that period differed essentially from the existing fauna in the total absence of Catenicellidæ, which form, as it may be said, one of the most characteristic features of the existing Australian marine fauna (so far as the Polyzoa are concerned). It now appears that in reality the Miocene fauna was as rich in those forms as it is now. Mr. Wilson enumerates about twenty extinct species, all, he says, different from the existing ones, which, so far as I am aware, do not amount to more than thirty.

When we consider that beyond the Australian region, including, of course, New Zealand, scarcely more than a single species of *Catenicella* is anywhere met with at the present time, and that none

* Tenison-Woods, Rev. J. E., "On the Genus *Amathia* of Lam., with a Description of new Species," 'Trans. and Proc. R. Soc. Vict.,' xvi. (1880).

† 'Journ. Micr. Soc. Vict.,' i. (1880) pp. 60–3.

have ever been met with fossil except in Australia, it would seem, so far as this evidence goes, that the Australian Polyzoan fauna was as peculiar to that region in the Miocene period as it is at the present day. The species all seem to have changed, it is true, but they do not appear to have either advanced or retrograded, since, according to Mr. Wilson, the Miocene fossil forms may be classified in the same groups as those of the present time.

This communication appears to me of the highest interest palæontologically, and it is much to be wished that we should have carefully drawn figures as well as descriptions of the forms mentioned, as in things so similar, verbal descriptions are insufficient for any critical purpose."

**Recent and Fossil Species of Australian Selenariadæ.***—The Rev. J. E. Tenison-Woods gives a short review of the Selenariadæ, a family of Polyzoa, and then proceeds to describe several new species of *Lunulites* and *Selenaria*, both recent and fossil. He considers the genus *Cupularia* of Busk a superfluity and unites it with the genus *Lunulites*, believing that *Cupularia* cannot even be maintained as a subgenus, as the same individual may sometimes have the features of *Cupularia* in one part and those of *Lunulites* in another.

This family is only represented by a few living species in the northern hemisphere, where, however, it was abundant in the Cainozoic and Neozoic periods, and the addition of twelve new species, of which four are recent, is an important addition to our knowledge of the family. All the species are well figured in two good lithographed plates.

## Arthropoda.

### *a*. Insecta.

**Undefined Faculty in Insects.**†—M. J. H. Fabre recalls the fact that *Ammophila* (Sand-wasp), boring its mine until a late hour of the day, abandons its work, after having closed the opening with a stone, goes to a distance, and yet knows how to return next day to its home, though the localities may be new and unknown. *Bembex* also has a similar power. Where human observation and memory are defective, their *coup d'œil* and remembrance have a certainty which is all but infallible. It may be said that there is in an insect something more subtle than the simple faculty of remembering—a kind of intuition of localities without analogy in man—and in order, if possible, to throw some light on this point M. Fabre instituted a series of experiments.

The first experiment was with twelve females of *Cerceris tuberculata*, which were caught, marked, enclosed separately in a box, and released in the fields two kilometres from the nests. They all went in a direct line towards their nests, and five hours later two were found there, and a third and a fourth soon followed.

* Tenison-Woods, J. E., "On some Recent and Fossil Species of Australian Selenariadæ (Polyzoa)," 'Trans. Phil. Soc. of Adelaide,' 1880.

† Fabre, J. H., 'Souvenirs entomologiques. Études sur l'instinct et les mœurs des Insectes.' 324 pp. (8vo, Paris, 1879.) See 'Entomol. Mon. Mag.,' xvii. (1880) pp. 100-2.

Another experiment was made with nine females, which were taken three kilometres from the nests, and after being kept in confinement all night were released, not in the fields, which may possibly have been more or less known to them, but in the public street of a town, in the centre of a populous quarter, to which the *Cercerides*, with their rustic habits, had certainly never penetrated. Each released *Cerceris* rose up vertically between the two rows of houses, as if to disengage itself as quickly as possible from the street; then, clearing the roofs, it launched out immediately, with a hasty flight, towards the south, where the nests were. The next day five of the insects were found at the nests (none being visible the previous day).

Transported to enormous distances, the pigeon promptly returns. If we compare the length of the passage and the bulk of the creature, the *Cerceris*, transported to a distance of three kilometres and returning to its nest, is much superior to the pigeon. The bulk of the insect is not a cubic centimetre, and that of the pigion amounts to quite a cubic decimetre. The bird, a thousand times larger than the hymenopteron, should, in order to rival it, regain its home from a distance of 3000 kilometres, three times the length of France from north to south. But power of wing, and still less clearness of instinct, are not qualities to be measured by the metre. The relations of bulk cannot here be taken into consideration, and we can only see in the insect a worthy rival of the bird without deciding which has the advantage.

When the pigeon and the *Cerceris* are artificially removed from home by man and transported to great distances into regions hitherto unvisited by them, are they guided by remembrance? Can memory serve them for a compass when, arrived at a certain elevation, they recover the lost point, and start, with all their power of flight, to that side of the horizon where their nests are to be found? Is it memory which traces their route in the air, to traverse regions they see for the first time? Evidently not; there can be no remembrance of the unknown. The hymenopteron and the bird do not know the place in which they find themselves; nothing can have informed them of the general direction in which their displacement may have been effected, for it was in the darkness of a close basket, or of a box, that the journey was made. Locality, orientation, are unknown to them; nevertheless they return.

They have, then, for a guide, something more than simple remembrance; they have a special faculty, a kind of topographical sense, of which it is impossible for us to have any idea, not having anything analogous to it.

**Nervous System of Oryctes nasicornis.***—Dr. Michelis devotes 70 pages and 4 plates to an account of the nervous system of this Lamellicorn Coleopteron, in its larval, pupal, and adult stages; like numerous of its allies, it is interesting from the fact that there is a great want of similarity between what is seen in the larval and in the adult form; in the former it is short and com-

* 'Zeitschr. wiss. Zool.,' xxxiv. (1880) p. 641–702.

pressed, so that, on superficial examination, there appears to be only one fused ganglionic mass, while, in the latter, the thoracic ganglia, at any rate, are separated from one another by extended longitudinal commissures. Is this difference due to a new formation, or to the elongation, as it were, of the separate parts of the cord? The result will show that his observations lead the author to be strongly inclined to adopt the latter view.

The cerebral ganglion of the larva is placed at about the middle of the head, and directly on the œsophagus; it consists of two lobes, pyriform in shape, and with their thickest ends approximated and directed anteriorly. There is some difference in the form of the masses in the younger and older larvæ. From the anterior surface there are given off four nerves for the mouth; at about the same place there arises the nervus recurrens, and behind these there is an unpaired nerve which goes to the œsophagus; shortly before this reaches the midgut it enlarges into a ganglion; very similar relations are, so far as this is concerned, seen in the adult, save only that the ganglia frontalia have considerably increased in size. The ganglia of the paired bucco-gastric nerves are similarly larger, and the double character which they had in the larva is exchanged for an apparent unity. On the other hand, the transverse commissure which connects these ganglia is much shorter than in the larva; the various intermediate stages between the two are to be made out in successive stages of the pupa. The same is exactly true of the commissures of the œsophageal ring. With regard to the ventral chain, the author is in agreement with Cuvier; in the larva it ends, so far as he has seen, at the point of separation of the second and third segments of the body. In a larva 2 cm. long it measured ·2 cm. and ·07 cm. broad; in one 3·4 cm. long, it was ·31 cm. long and ·075 broad; in the adult stage it measured ·79 cm., while the length of the ganglia amounted to ·52 cm., a length which had been observed in some of the oldest of the larvæ; the agreement between the two is sufficiently striking, and it only remains to note that the breadth was in the adult somewhat greater, being in the proportion of eleven to nine in the larva.

The author enters into a detailed description of the nervous system, an account of which would be altogether unintelligible unless it were accompanied by the figures with which he illustrates it.

The second portion of the paper deals with the relations of the tracheal to the nervous system; and the third with an account of the more minute structure of the ventral cord. In the larva there are two investing layers, which are distinguished as the outer and the granulo-cellular neurilemma; the former is an obscurely striated membrane, with elongated nuclei embedded in it. The latter forms a stratum of finely granular substance, with clear rounded nuclei; there are no definite boundaries to its cells; it is feebly developed on the dorsal, and well developed on the ventral surface of the cord; it is the part which, in connection with the tracheæ, produces the segmentation of the ventral cord. The ganglion cells surround the central fibrous layer in an almost continuous investment, save at the median plane, where the cells of the neurilemma are best developed; they vary greatly in size.

Referring to the paper for the other important details with which it abounds, we find, as a general conclusion, that the separate ganglia of the adult do not arise from any new formations, but from the extension of the ventral cord of the larva; the peripheral nerves are the same in both; there is no histolysis of the larval nerves, but a growth of the nerve-trunks. In both, there are the same number of ventral ganglia, both have similar relations to the tracheal system, and intermediate conditions are to be seen in the pupa. There is no "dotted substance" as Leydig understands the term, and no true transverse commissures; instead of these there are a large number of transverse bundles, which, on the one side, arise from the ganglia, and on the other, form the peripheral nerves.

**Activity of Bees.***—The paper of E. Erlenmeyer and A. v. Planta-Reichenau is a sequel to former reports † on a similar subject, being further experiments made to ascertain whether the wax secreted by bees is derived from the sugar and other carbo-hydrates which are found in the nectar of the flowers, or from such nitrogenous matters as exist in the pollen.

A healthy swarm was bought in February, well cared for and fed, and at the beginning of the experiments was in a very healthy condition. A determined number of the bees was carefully weighed, and, with the queen, transferred to the experimental hive, which was furnished with all appliances requisite for carrying out the experiments. The food was weighed in tared capsules. Before the weighing of the swarm, fifty of the bees were killed with chloroform vapour, and used for fat and nitrogen determinations. Each experiment lasted four days and four nights, and for a whole day the animals were confined to the hive.

The bees were first fed with a solution of sugar-candy, and a remarkable yield of wax was the result. The suggestion was made that the albumen in their bodies contributed to it, but both the nitrogen and the fat were the same before and after the experiment. A second trial was made by feeding the bees on honey, but the quantity of wax produced was less. Further observations, extended over longer periods, were made, with a view to see what effect temperature would have on the production of wax. The first, made during favourable weather, on sugar-candy solution mixed with 1 per cent. of wheat-flour, gave very good results; the second, carried on simultaneously, on honey and wheat-flour, gave good, but still inferior results; the third, with the same food as the first, but in less favourable weather, gave a much inferior yield; in another experiment the small proportion of 0·22 per cent. dry gelatine was added to the sugar solution, with unsatisfactory results, whilst a much larger proportion of gelatine, 1¼ per cent., added to honey produced a very large amount. When, however, the quantity of gelatine was increased to

* 'Bied. Centr.,' 1880, pp. 191-3. See 'Journ. Chem. Soc.,' Abstr. xxxviii. (1880) pp. 725-6.

† Ibid., p. 115.

5 per cent., and when a mixture of 20 parts peptone and 20 parts honey was employed, the bees refused their food altogether, and most of them died. A mixture was made of 1·18 parts glutinous peptone, 100 parts sugar, and 60 parts rose-water; it was all eaten, but neither honey or wax produced; the bodies of the bees were distended, their honey-bags full, but their stomachs empty. A mixture of 342 grams sugar-syrup and 28 grams egg-albumen was also quickly consumed, but no honey or wax obtained. A similar mixture of egg-yolk (24 to 414 sugar-syrup), produced a small proportion of wax only.

As general results, the authors believe that the food of bees should not be highly nitrogenous, and that beeswax is formed from non-nitrogenous substances, especially sugar. Erlenmeyer is further of opinion that the fatty portions of the bees' bodies are formed solely from hydrocarbons, the albumenoids only playing the part of nourishment to the active organs, keeping them in working order and supplying waste.

**Scent-organs of the Male Privet Hawkmoth.***—Herr W. von Reichenau, as already briefly reported,† following up Dr. Fritz Müller's discoveries in this direction, finds both the privet and pine hawk-moths to be provided, in the imago state, with a special scent-organ at the edge of the lower side of the first abdominal segment; it comes into view on pressure of the abdomen of the dead or living insect, and consists of two symmetrical bunches of hair-shaped scales, which may be extruded or drawn in. When they are extruded in a living *Sphinx ligustri*, a distinct musky scent is apparent at the distance of half a metre; but ceases when they are retracted into their fold, which occurs when the insect is at rest. In minute structure they are really capillary tubes, tapering gradually to points, and filled with globules of the scent substance; they do not spring simply from depressions in the chitinous skeleton, as do the ordinary scales, but are rooted in, and radiate from, a sac common to them all; this sac contains an opaque white mass, and is capable of being stretched by two muscles attached to the ends; in it the hairs stand close together, united by a long band of tissue, and each implanted by a pincer-shaped root.

The parts probably act as follows:—The moth, when excited, acts by its nervous system on the muscles of the segmental fold, so that they open the latter, transforming it into a boat-shaped groove; at the same time the muscles of the base of the hairs exercise a tension upon the band which unites the bases of these, and causes them to become arranged as a radiating, instead of a converging group; when these muscles cease to act, the hairs converge again and retreat into the fold. The muscles also act by stretching the basal sac, so that its white contents are pressed against the roots of the hairs, and entering them, expel some of the contained scent material through the tips. The fact that the hairs are never found empty is explained, either by the extreme diffusibility of small quantities of the scent, or by its replacement by some of the white substance from the base.

The object of these organs, of which only a rudiment is present in

* 'Kosmos,' iv. (1880) p. 387.

† See this Journal, *ante*, p. 780.

the female, is probably to enable the male to exercise a charm over its partner.

The importance of these modified scales is greater than that of the normal ones which colour the wings, as these are almost invisible in the dusk; and they show an important connection existing between scent and alimentation, for it is found that insects choose, as flowers from which to feed, those whose scent most nearly resembles their own. The privet hawk-moth, for instance, prefers the musk-scented *Weigelia*, and second to it, the *Petunia*, smelling of honey and musk; the *Zygænæ*, which emit an odour like that of honey, prefer the honey-scented Scabious best.

**Morphology of the Suspensory Organs of Chrysalids.***—M. Künckel points out how little knowledge as to this subject has been definitely acquired since the time of Réaumur. That eminent naturalist described how the tail of the chrysalis was separated from the integument of the caterpillar, and became attached by the hooks with which it is furnished. The author has again investigated this subject, and has come to the conclusion that the chrysalids have no real tail at all.

Examining the chrysalis of Papilionids or Nymphalids, he has seen that the "tail" is formed by the union, along the median line, of a pair of appendages; these have each a series of hooks, and they belong to the twelfth ring of the chrysalis, in which there are no stigmata. The appendages surround the extremity of the abdomen and circumscribe the anus; when ecdysis occurs the *Papilio*, on losing its suspensory apparatus, loses its anal appendages. These last may, especially in many genera of the Notodontidæ, take on very various forms. In *Dicranura* they are two retractile prolongations; in *Platypteryx* they are united for some part of their length, and are no longer retractile; in *Uropus* they are somewhat similar to the same parts in *Dicranura*, but they have a more distinct pediform character, and they also have a crown of hooks. Their power of modification easily leads us to see how they became suspensory organs.

Further information may be gained by taking a caterpillar, just before the period of metamorphosis is completely reached; the best examples are to be found among species of the genus *Vanessa*. If ecdysis be hastened by treatment with alcohol or chromic acid, it is possible to see that the posterior extremity of the chrysalis is entangled in the twelfth ring of the caterpillar, and that the parts which carry the suspensory hooks (the "tail" of many authors) are hidden under the integument of the anal appendages of the caterpillar.

It follows, therefore, that the chrysalids of the Lepidoptera attach or suspend themselves by the hooks of the membranous anal appendages, which are modified and adapted to the special conditions of their life.

**Preservation of the Chrysalis from Cold.**†—Dr. Jousset de Bellesme was led to the consideration of the question whether the

* 'Comptes Rendus,' xci. (1880) p. 395.

† 'La Nature,' viii. (1880) 1er semestre, p. 83.

cocoon preserves the chrysalis from extreme cold by finding in the month of March (1872) some cocoons of *Attacus cynthia* suspended to the branches of the trees in the abbey garden of Saint-Germain-des-Prés. Specimens of these moths had been introduced by Babinet in 1860, and, unattended by any one, had bred there since; the successive generations successfully supporting the cold of eleven winters. The winter of 1871-2 had been excessively severe. In Paris the mean temperature from the 8th to the 19th December, 1871, had remained at $-9°$ C. and on the 21st the thermometer descended to $-20°$, remaining at $-18°$ for twenty-four hours. Dr. Bellesme was therefore surprised to find the chrysalids in a complete state of preservation, the perfect insect emerging in due course. This unlooked for resistance to congelation could only be due to one of two causes; either the almost absolute non-conductivity of the silky covering, or the production of a notable quantity of heat on the part of the insect. The latter alternative seemed improbable considering the immobility of the nymph.

Dr. Bellesme proceeded to test the conductibility of the cocoon, and having opened one and extracted the chrysalis, he inserted the bulb of a sensitive thermometer in its place, securing the cocoon round it with an elastic band, and arranged it so that the bulb of the instrument did not touch the cocoon anywhere. The cocoon thus prepared was introduced, in company with a thermometer for comparison, into a testing-glass, surrounded by a freezing mixture. Before the experiment both thermometers marked 18°; five minutes after their introduction into the test-glass they were withdrawn, when both marked 9°. On suspending them in the open air the comparison thermometer rapidly rose, and in a few moments had regained its former level of 18°; after ten minutes, the thermometer which had the cocoon tied over it stood at the same point.

If, therefore, the nymph resists congelation, it does so by virtue of a continuous and considerable disengagement of heat. It is extremely probable that this heat is produced at the expense of the organic transformations which take place within. There is the disappearance of certain muscles which have served the larva and the formation of new ones to be used by the perfect insect. But the muscular system of the larva is far more considerable than that of the perfect insect; all the heat rendered available by the destruction of the old muscles is not, therefore, used up in the construction of new ones. Moreover, uric acid and its derivatives are very abundant in the recently metamorphosed insect, another sign of the existence of active combustion during the nymphal period. To these organic-chemical phenomena must then, apparently, be attributed the facility with which insects, in course of transformation, support prolonged low temperatures.

**Wing-muscles of Insects.***—N. Poletaiew describes the difference between the wing-muscles of the Lepidoptera and of the Libellulidæ.

Those of the former may be arranged in three groups: (1) a median

* 'Zool. Anzeig.,' iii. (1880) p. 212.

paired dorsal muscle; (2) lateral and dorsoventral muscles of the meso- and metathorax; (3) median dorsoventral which raise, while the other two sets depress, the wings. Only two muscles are inserted by means of tendons into the wings, the rotation-axes of which lie parallel to the axis of the body.

The Libellulidæ want the median wing-muscle; each of their chief muscles is provided with one or two very small accessory muscles. Owing to the structure of their wings the muscles are inserted directly at the base of the thickened nervures of the wing, and all have a superior, and some, in addition, an inferior tendon, while the rotation axes of their wings are set at an angle of from 30° to 55° to the longitudinal axis of the insect itself.

**Salivary Glands of the Odonata.***—The salivary glands of the Odonata (Dragon-flies), although denied by entomologists, exist, says Herr Poletaiew, in all the species of the three families of this sub-order of insects.

In their structure they present the characters common to acinous glands, and consist of lobules, or glandular grains (acini), whose excretory canals unite by degrees into two principal ducts, one for each gland. These lobules, elongated, and of an oval form, are more numerous in the Æschnidæ and Libellulidæ than in the Agrionidæ. *Æschna grandis* L., for example, has more than 150 of them, whilst *Lestes sponsa* Hansen, has only sixty. In the two first-named families, moreover, these lobules are closer, and more interlaced by the tracheæ.

The salivary glands are situated in the prothorax, near or over the first thoracic ganglion. Generally they are in front of the latter, and at the same time in front of the anterior depressor of the wing. In some Libellulidæ—the smallest ones—they are further back, reaching even to the elevator of the anterior wing (e. g. *Libellula scotica* Donov.). The whole cluster affects an oval form. Each of the two principal canals, after reaching the interior of the head, enlarges into a sac or bladder, oval or spherical in form, then is continued as a very short tube, and meeting its congener, constitutes a single duct which opens directly into the mouth under the tongue (*ligula*).

**Mode of Respiration in the Larvæ of the Genus Euphœa (Libellulidæ).**†—Mr. H. A. Hagen describes this as follows:—

On each side of segments 1–8 of the abdomen is a conical branchial appendage with unravelled edges; three strong, equal, cylindrical, caudal, branchial appendages; the rectal branchiæ formed of three simple columns.

The existence of lateral branchial abdominal appendages is known in the genus *Sialis*, but is altogether unique in the Odonata. Respiration in the larva of *Euphœa* is thus possible in four different manners: (1) by stigmata, two on the thorax and eight on the abdomen; (2) by lateral branchial appendages well provided with

* 'Comptes Rendus,' xci. (1880) p. 129.

† 'Comptes Rendus Soc. Entomol. Belg.,' meeting of 1st May, 1880.

tracheæ; (3) by caudal branchial appendages equally well provided with tracheæ; (4) by rectal branchiæ formed of three columns in the mucous system of the rectum, well provided with tracheæ. No doubt the four kinds of respiration do not act simultaneously, and the stigmata of the abdomen probably never, as they only receive a simple tracheal branch, but the stigmata of the prothorax are provided internally with numerous well-developed tracheæ, and perhaps serve for the expulsion of used air.

Mr. R. MacLachlan, in commenting * upon the preceding, describes it as "a most important physiological discovery, and showing how little is yet known of the structure of the larvæ of dragon-flies. The beautiful genus *Euphœa* inhabits tropical Asia and the islands of the Eastern Archipelago."

**Poduridæ from Switzerland.**†—Dr. G. Haller records the capture of four species of Poduridæ, two from the canton of Berne, and two apparently from near Zürich.

Of the former cases, one is that of *Achoreutes purpurascens* Lubbock, which occurred over an extent of 10 metres of a road, in the puddles; the other, that of an apparently new species of the same genus, which was found in patches on damp earth of some millimetres in depth, and in one instance of about 16 square inches in extent. The name *A. Schluppii* is proposed for this form, which is distinguished by the large size of its head (one-third the length of the body, which does not exceed 1 millimetre). The antennæ are very thick, and dark violet in colour; the head is light reddish brown; the body is remarkably constricted between the sixth and seventh segments, and varies from brick-red colour to near that of *A. purpurascens*. The whole is covered with short bristles, which are of larger size on the abdomen.

The new genus *Lubbockia* is formed to contain a species found in moss near Zürich, and closely allied to *Achorcutes*. The genus is thus defined: "Body cylindrical, segments subequal. Eyes? Antennæ extended, longer than the head, slender, five-jointed. Accessory claws on the four front feet very small, scarcely to be distinguished; plainer on the third pair. No scales or knobbed hairs, but two strong, slightly bent pairs of spines, near the hind margin of the body. Leaping-fork very small." The species is named *L. cœrulea*. The body is dark blue above, lighter below; the spines are golden yellow. Hairs occur, at some distance apart, on the legs and on the upper part of the body. Total length $1\frac{1}{3}$ millimetre.

A new species of *Isotoma*, *I. Turicensis*, is described, from moss in the same locality as the *Lubbockia*. Its back is blue-black, the ventral surface lighter; anal spring and legs below the coxæ, almost colourless. Terminal segment of fork ending in three tiny warts. Body clothed with closely set, colourless hairs, mixed with a smaller number of bristles. Two large bristles near the hind edge of the legs. Length about 1 millimetre. Closely allied to *I. arborea* Lubbock.

* 'Entomol. Mon. Mag.,' vii. (1880) p. 90.
† 'MT. Schweiz. Entomol. Ges.,' vi. (1880) p. 1.

### β. Myriapoda.

**Segments of the Geophilidæ.***—Dr. Sseliwanoff describes the structure of the segments in these forms.

Each body-segment, though bearing only a single pair of legs, is clearly enough made up of two segments. In these the numerous small lamellæ which form the lateral parts, are arranged in two transverse series. The number of these lamellæ is greatest in the lowest forms, while in those more highly developed the lamellæ either fuse with one another, or partially disappear. The same remark applies to the distinctness of the two component segments connected with each pair of appendages. The author is also reported to have made some observations on *Bothriogaster*.

### γ. Arachnida.

**Poison-organs of the Spiders.**†—M. MacLeod, in this preliminary communication, deals chiefly with the histological characters of these organs. Among the forms examined are *Epeira diadema*, *Agelena labyrinthica*, and *Tegenaria domestica*.

In all these forms there are two poison-glands, each of which presents a pyriform glandular body, invested by a layer of spirally arranged muscular fibres, and an excretory canal, which opens at the extremity of the chelicerae. The gland is either placed in the cephalothorax, immediately below the dorsal integument, or partly in the cephalothorax and partly in the basal joint of the chelicerae. Its wall is seen to be composed, from without inwards, of the following layers:—(*a*) a muscular tunic; (*b*) a glandular epithelium. The former is made up of a single layer of striated fibres, and is everywhere of the same thickness. The transverse striation, though always distinctly apparent, is but feebly marked. The longitudinal striæ are, on the other hand, very distinctly visible. The numerous nuclei are very regularly arranged in longitudinal rows, and as many as four rows may be made out in a single fibre. On either side of the muscular layer there is an investment of connective tissue, and they are connected together by regularly arranged septa, which traverse and separate from one another the longitudinal constituents of the muscular layer. The elements of the glandular epithelium vary according to the age and species of the specimen under examination. In a young *Agelena* they are cylindrical, with deeply set nuclei; in the adult the cells are more distinctly calyciform, and there is a narrow tube, three or four times as long as the protoplasmic portion of the cell. Numerous intermediate stages between the extreme forms are to be noted.

The excretory canal arises from the narrowest part of the gland, but the muscular tunic is formed of striated fibres, which are arranged spirally around the organ, and which are much more delicate and more widely separated from one another. The epithelial layer, which invests the inner face of the internal layer of connective tissues, is

* 'Zool. Anzeig.,' iii. (1880) p. 167.
† 'Bull. Acad. R. Sci. Belg.,' l. (1880) pp. 110–13.

made up of very small cells, which are cubical in form and regular in arrangement.

**Pentastomum polyzonum.***—Professor Jeffrey Bell has been able to rediscover this species in an African python which died in Wombwell's menagerie. The species was shortly described and well figured by Dr. Harley in the 'Proceedings' of the Zoological Society for 1857, the specimen being from the collection of Dr. Sharpey, but having no history. A careful comparison of the two specimens in the British Museum with Dr. Harley's figure, and an examination of other species, seems to show that the number of the rings of the integument is pretty definite for each form; *P. polyzonum* having nineteen rings, and *P. annulatum* Baird (described by Harley under the name of *P. multicinctum*), having twenty-seven or twenty-eight.

### δ. Crustacea.

**Anal Respiration of the Crustacea.**†—In a former note ‡ Mr. M. Hartog suggested that the zoea larva of the higher Crustacea would, on examination, prove to breathe in the same way as the Copepoda. Zoeas of *Cancer*, and probably of some species of prawn, have confirmed this amply. The respiratory diastole and systole of the rectum with rhythmical openings of the anus, are thoroughly well marked. It may here be noted that in carmine stainings of the entire Copepoda the stain does not diffuse through the integument, but up through the rectum in the first instance. The power of dialysis through the chitinized integument is slight, if at all existent. Now that another place is found for the respiratory function, it may be denied to the expanded pleura of the carapace.

This constancy of function in the anus is remarkable, and indicates that the gills which characterize so many of the higher Crustacea are secondary formations, long posterior to the differentiation of the class. As to their origin? They are probably, in all cases, modifications of those processes of the appendages which primitively bring about nutritive currents.

**Genealogy of the Mysidæ.**§—Herr Czernjawsky has given an account of his speculations on this subject. He has been examining thirty-two species, most of which are new, and has noted very remarkable variations in the locomotor organs, and in the parts of the mouth, as well as in the brood-cavity of the mother. He comes to the conclusion that the Mysidæ form a side-branch of the great Crustacean phylum, and that this branch began at the same point as that of the Macrura, which, for its part, gave rise to the Brachyura and the Anomura. The fact that the auditory organ of the Mysidæ is placed in the caudal appendages, and in the Macrura at the base of the antennæ, seems to prove to the author that the latter are not derived from the former.

* 'Ann. and Mag. Nat. Hist.,' vi. (1880) p. 173.
† 'Quart. Journ. Micr. Sci.,' xx. (1880) p. 485.
‡ See this Journal, *ante*, p. 633.
§ 'Zool. Anzeig.,' iii. (1880) p. 213.

The ancestor of the two groups is to be found in the Mysis-stage of the Decapoda (Fritz Müller). The ancestors were pelagic forms, with three flagella to the superior antennæ, and with biramose abdominal swimming feet in both sexes. So far as the present existing Mysidæ are concerned the third flagellum is only retained in the male of *Podopsis.* This is somewhat remarkable, as this genus is one of the most retrograde of its group. In the other genera there is no indication of it whatever. Among the Macrura, *Palæmon* has a third flagellum, more or less well developed, and in the more lowly representatives it is still well marked. The abdominal feet are still swimming organs in the Macrura, but in forms of Mysidæ which were examined, those parts never had that function in both sexes. In the former the right and left mandibles are equal, but in all Mysidæ they are unequal, and are generally very different.

Basing his argument on the conclusion to which he has arrived, that where the male differs most from the primitive form, the group to which it belongs is progressing, and that, on the contrary, where the female exhibits the most marked divergence, the group is retrograding, the author concludes that the Mysidæ are degenerating. This may be shown by the abdominal appendages, for in the male there is a gradual series of atrophy, while in the female they are nearly always completely rudimentary ; so, too, the male Mysidæ often retain their pelagic habitat.

The author concludes with an indication of the characters by means of which the relations of the different genera, and their history, are to be made out.

**Nest-building Amphipods.***—Mr. S. J. Smith, in a paper on some Amphipods described by T. Say, states that the tubes which certain species make to live in are to a great extent formed of pellets of their excreta.

In 1874 he watched carefully the process of constructing the tubes in several species of Amphipoda. *Microdeutopus grandimanus* (*M. minax* Smith) was a particularly favourable subject for observation.

When captured and placed in a small zoophyte trough with small branching algæ, the individuals almost always proceeded at once to construct a tube, and could very readily be observed under the Microscope. A few slender branches of the alga were pulled toward each other by means of the antennæ and gnathopods, and fastened by threads of cement spun from branch to branch by the first and second pairs of peræopods. The branches were not usually at once brought near enough together to serve as the framework of the tube, but were gradually brought together by pulling them in and fastening them a little at a time, until they were brought into their proper position, where they were firmly held by means of a thick network of fine threads of cement spun from branch to branch. After the tube had assumed very nearly its completed form, it was still usually nothing but a transparent network of cement threads woven among the

* 'Trans. Connect. Acad.,' 1880. See 'Nature,' xxii. (1880) p. 595.

branches of the alga, though occasionally a branch of the alga was bitten off and added to the framework; but very soon the animal began to work bits of excrement and bits of alga into the net. In this case the pellets of excrement, as passed, were taken in the gnathopods and maxillipeds, and apparently also by the maxillæ and mandibles, and broken into minute fragments and worked through the web, upon the outside of which they seemed to adhere, partially by the viscosity of the cement threads, and partially by the tangle of threads over them. Excrement and bits of alga were thus worked into the wall of the tube until the whole animal was protected from view, while, during the whole process, the spinning of cement over the inside of the tube was kept up.

When spinning the cement threads within the tube, the animal was held in place on the ventral side by the second pair of gnathopods and the caudal appendages, the latter being curved beneath the anterior portion of the pleon, and on the dorsal side by the third, fourth, and fifth pairs of peræopods extended and turned up over the back, with the dactyli turned outward into the web. The spinning was done wholly with the first and second peræopods, the tips of which were touched from point to point over the inside of the skeleton tube in a way that recalled strongly the movements of the hands in playing upon a piano. The cement adhered at once at the points touched and spun out between them in uniform delicate threads. The threads seemed to harden very quickly after they were spun, and did not seem, even from the first, to adhere to the animal itself.

**Development of Orchestia Montagui and O. Mediterranea.***—Herr Uljanin gives an account of his observations on the early stages in the development of these "sand-fleas."

He deals especially with the formation of the blastoderm and of the germinal layers. He was unable to detect the germinal vesicle. Sections showed in each of the four cleavage spheres a stellate cell; these cells pass to the periphery gradually. They are of considerable size, and consist of a granular protoplasm, which gives off more or less long filamentous processes. Their nucleus is large, and there are also two or three nucleoli. It is they alone which give rise to the later blastoderm cells. At the time when there are, altogether, thirty-two cells, the cleavage spheres begin to get indistinct boundaries, and, a little later on, the limits between them disappear altogether. The smaller and peripheral cells which go to form the blastoderm become closely appressed, and the whole mass takes on a polygonal form. This portion, when complete, covers over nearly two-thirds of the surface of the egg, and consists of cubical, somewhat elongated cells. The mesoderm commences to be developed before the ectoderm is completely formed. It clearly enough owes its origin to that layer, arising close to the edge of the blastoderm disk in the form of a small rounded thickening. In the course of growth it reaches to the opposite side of the egg, or to that at which the dorsal region of the animal is, later on, developed. Now is shed the so-called cuticle of the blastoderm.

* 'Zool. Anzeig.,' iii. (1880) p. 163.

The "spherical organ" is regarded by the author as being the homologue of the shell-gland of the Mollusca; both are local invaginations, and while one gives rise to the shell the other forms the blastoderm cuticle. It has also a relation to the formation of the ectoderm and mesoderm, for at the time when the first signs of the extremities become apparent, and the spherical organ has taken up a definite position, the yolk, lying below this last, begins to break up into spheres, and this change gradually extends over the mass. It would seem probable that these "Ballen" have their origin in the spherical organ, and it may be that the cells of the ectoderm arise from the base of the invagination.

**Structure of the Eye of Limulus.***—Dr. A. S. Packard, jun., writes:—

The eyes of the horse-shoe or king crab are four in number, consisting of a pair of compound eyes situated on the side of the head, and a pair of small, simple eyes on the front of the head. As described by A. Milne-Edwards and Owen, the optic nerves to these eyes are very long, and close to each eye subdivide into an irregular plexus of fine nerves, a branch being distributed to each facet composing the compound eye. The structure of the eye is very unlike that of any other Arthropod eye. The cornea is simply a smooth convex portion of the integument, which is much thinner than the adjoining part of the chitinous skin. There are no facets, the cornea externally being structureless, simply laminated like the rest of the integument. On the internal side of the cornea are a series of solid chitinous conical bodies, separated from one another by a slight interspace, and in form resembling so many Minié-rifle balls. The conical ends of these solid cones project free into the interior of the body, and are enveloped in a dense layer of black pigment. Within the base of these cones are secondary, shallow, cup-like bodies, or shallow secondary cones. It is these primary cones which, seen through the smooth, convex, translucent cornea, give the appearance of a faceted surface to the external eye.

All the parts thus far described, except the pigment layer, are moulded with the rest of the crust; and the large, long, slender cones can be easily seen by viewing a piece of the cast-off eye, the solid cones being seen projecting from the inner surface of the cast-off cornea.

The internal structure of the eye is very simple. *There are no cones and no rods*, but a branch of the optic nerve impinges directly upon the end of the solid chitinous cone, as determined by removing the layer of pigment with dilute potash, and treating the section with acetic acid, and then staining with picrocarmine. So far as the author can ascertain, no Arthropod eye is so simple as that of *Limulus*.

The observations were based on a study of the lobster's eye from preparations of very great beauty and delicacy, made for him by Mr. N. N. Mason, of Providence, who has also made beautiful sections of the *Limulus* eye, after treating them in various ways. The question

* 'Am. Natural.,' xiv. (1880) p. 212.

as to the nature of the solid cones he is not yet prepared to settle. Are they crystalline lenses or only analogous organs? Can the horse-shoe crab distinguish objects? He doubts if its eyes enable it to more than distinguish between the light and darkness.

**Eye of Trilobites.*** — Dr. Packard has also investigated the internal structure of the hard parts of the eye of Trilobites; only the entire eye, the external anatomy of the cornea, and the form and number of the facets having been previously described and figured by Burmeister, Barrande, and others.

From the facts presented it would seem evident that the hard parts of the eye of the Trilobites and of *Limulus* are, throughout, identical. The nature of the soft parts will, as a matter of course, always remain problematical, unless the dark line which seems to run across from one lens to another really represents the outer edge of the pigment of the retina; but however this may be, judging by the identity in structure of the solid parts, we have, reasoning by analogy, good evidence that most probably the eye of the Trilobites had a retinal mass like that of *Limulus*, and that the numerous small branches of the long, slender, optic nerve (for such it must have been) impinged on the ends of the corneal lenses. It has been shown by Grenacher and the author, that the eye of *Limulus* is constructed on a totally different plan from that of other Arthropods; and he now feels authorized in claiming that the Trilobite's eye was organized on the same plan as that of *Limulus;* and thus when we add the close resemblance in the larval forms, in the general anatomy of the body-segments, and the fact demonstrated by Mr. Walcott that the Trilobites had jointed round limbs (and probably membranous ones), we are led to believe that the two groups of Merostomata and Trilobites are subdivisions or orders of one and the same subclass of Crustacea, for which he previously proposed the term Palæocarida.

**New Entomostracon from Afghanistan.†**—Dr. F. Day describes (from a collection made by Dr. Duke in Afghanistan) a new entomostracon—*Apus dukianus*—captured in a pond near Kelat in 1877.

Superiorly the general colour of the carapace is olive, the spinous projections sienna, and the body and tail dull yellow. The largest example is 1·4 inch long, 0·6 inch in width, while the caudal appendages are 0·7 inch in length. The caudal portion of the body is twice as long as the carapace. The segments of the body have each a transverse row of from six to eight short, spinous elevations directed backwards, the lateral spine being that most developed. The joints of the caudal appendage are similarly, but less strongly armed, to those of the body. The entire extent of the semilunar notch at the posterior extremity of the carapace is armed with very fine and short needle-like points, all being of about the same size; while under the Microscope the hind portion of the carapace's outer edge is also seen to be minutely and evenly armed with fine points.

* 'Am. Natural.,' xiv. (1880) p. 503. (4 figs.)
† 'Proc. Zool. Soc. Lond.,' 1880, p. 392. (1 fig.)

The great comparative length of the body of this species distinguishes it from known forms of *Apus*, while its carapace is relatively smaller and armature less developed.

## Vermes.

**Genital Glands and Segmental Organs of the Polychæta.***—In continuing, in a further number of M. Lacaze-Duthiers' 'Archives,' his further account of this subject, M. Cosmovici deals with it in a comparative manner.

The result of his researches may be thus summed up:—Taking for examples *Arenicola piscatorum* and *Terebella gigantea*, we find that the "pouches of the body-cavity" are composed of two parts; one is voluminous and glandular, comparable to the molluscan organ of Bojanus; plexuses of blood-vessels are found in its wall, its interior is lined by a very thick layer of pigmented cells, the most superficial of which have vibratile cilia; the organ communicates with the interior by a pore, and crystals of uric acid are to be found in it. The second portion is a bell-shaped organ, with two lips; one of these, more or less richly ciliated, is traversed by a blood-vessel; the organ is continuous with a funnel of varying length; connected with the glandular portion, it is obviously a *segmental organ*, and serves as the oviduct in the female and the sperm-duct in the male. In the Serpulidæ and Hermellidæ the two parts are distinct. In the sedentary Annelids we find, then, two kinds of organs. The organs of Bojanus vary in their number and disposition in the different genera and species. The segmental organs, which may or may not be connected with the organs of Bojanus, similarly differ in different forms; their function is to collect the generative products which float in the cœlom and to pass them outwards. The more the animal rises in the scale of development of the Annelidan type the closer is the connection between the two sets of organs; the sedentary are more elaborately developed than the errant forms, and thus it is in them that the two parts are more closely connected. With the exception of the two families already mentioned—the Serpulidæ and the Hermellidæ—the segments of the body greatly lose their "individuality."

As to the genital glands, the researches of the author have convinced him that there are two organs of this kind, both male and female, and that they are constant in position. Only in the "beau temps" do they become visible; they are racemose and attached to a blood-vessel; each acinus of the gland is surrounded by a delicate membrane, capable of distension. The nuclei seen in the contained protoplasm are the germinal spots of the future ova; around these nuclei the amorphous protoplasm becomes collected, and the ova are driven forward by the development of fresh protoplasm at the base of each acinus. The ripe eggs fall into the cavity of the body and escape to the exterior through the ducts of the segmental organs. The testes present a similar history. The genital glands are to be

* See this Journal, *ante*, p. 635.

found in young specimens, and it may be of interest to add that *Arenicola* especially lends itself to these investigations.

*Spirorbis communis* is to be added to the few species of Polychæta which are, as yet, known to be hermaphrodite. The author thinks that further investigations will show that the same is true of many other species of that genus.

Not much is known as to the mode of oviposition. *Terebella conchilega* extrudes its ova one by one; after a little it changes its place, turns over on to the other side, and lays more; it probably lays its eggs in different places. Many, and especially the Opheliadæ, deposit their eggs in gelatinous masses, in the centre of which there is a water-tube. In this case it appears probable that the male afterwards visits the ova, and that the sperm passes in by this tube.

The second chapter of this very elaborate paper (which extends altogether over 144 pages, and is illustrated by ten plates) deals with the Terebellidæ, and the parts discussed are arranged in sections as follows:—(1) The animal; body; organs of nutrition; (2) organs of excretion and reproduction, organ of Bojanus, segmental organs, ovary and testis. The third chapter deals with the Opheliadæ, in which a few remarks are made on the history of their development. The fourth chapter deals with the Chætopterini; the next with the Serpulidæ, of which *Sabella arenilega* and *Myxicola modesta* were chiefly studied. The sixth chapter, dedicated to the Clymenidæ, is especially occupied with *Clymenia zostericola*, which appears to be abundant at Roscoff. The Pectinaridæ occupy the seventh chapter; the Hermellidæ the eighth. In the introduction to this the author repeats that, for the purpose of distinctly seeing the segmental organs, it is necessary to have living specimens. The second part of the essay deals with the Errant Annelids, of which four families only were studied. The representatives of these were *Hermione*, *Sthenelais*, *Cirratulus*, *Nereis*, and *Marphysa*.

The author would seem to be much impressed by the way in which the organs examined differ in different species.

**Copulatory Organs of Microphthalmus.***— Dr. Bobretzky, in describing these organs, states that *M. fragilis* and *M. similis*, the two species found at Sebastopol, are both hermaphrodite, and that the male sexual products are exclusively developed in the segments of the anterior, and the female in those of the posterior half of the body. These annelids are also characterized by the fact that their cœlom is more or less completely filled up by connective tissue; when we find an animal with the sexual products matured, we may see two male copulatory organs, which are attached to the body at the point of union of the second and third setigerous segments; each consists of two fleshy lips, with a median penial papilla, at the centre of which there is placed the orifice of the vas deferens. This duct has a ciliated internal orifice; the ripe zoosperms chiefly become collected together at the sides of the enteric canal. In each segment of the

* 'Zool. Anzeig.,' iii. (1880) p. 139.

female or hinder portion of the body there are two somewhat spacious sacs, often found filled with zoosperms; each of these communicates with a narrow tubular canal, which opens into the cœlom by a ciliated infundibulum. There is also another opening connected with these sacs, the function of which is evidently that of a receptaculum seminis; these open to the exterior at the base of their proper paradopodia. It is further to be noted that these sacs resemble in their structure and arrangement segmental organs, and this is the more obvious in young specimens in which the sexual products are still undeveloped. The author is unable to decide definitely whether the male copulatory organs are also to be regarded as modified segmental organs.

**Development and Classification of the Echiurida.***—Dr. Hatschek has been fortunate enough to find a series of an Echiurid larva, of which he gives an account. They were distinguished from the species examined by Salensky not only by the fact that they were considerably larger and exhibited a somewhat more complex development of the organs, but also by the striking fact that they had not one only, but two circlets of setæ at their hinder ends.

The series exhibited a very marked increase in size, the specimens being all within a month's development.

The *trochophore-stage* includes all the phases of the unsegmented animal. In this it is possible to detect all the parts which were seen in the same stage in *Polygordius;* there is no distinction externally between the head and trunk, and the latter is, at this period, very inconsiderable. In the cephalic region there is a double-rowed pre-oral, and a single-rowed post-oral ciliary circlet, while between them there is the adoral ciliated zone; in addition to this there is a ventral band between the mouth and anus. This region, later on, becomes deepened into the ventral (neural) groove. At the interior pole of the body there is a transversely elongated frontal plate, which is formed by a thickening of the ectoderm, and is likewise ciliated.

The limits of the cells of the ectoderm can only be distinguished in some parts, and in the rest they have to be made out by the arrangement of the nuclei. The mesodermal structures are thus arranged. In the trunk, and lying close to the ectoderm, there are very short mesodermal bands; these commence by two large oval cells placed just in front of the anus, and touching one another in the middle line; they are easily distinguished by their cleavage-sphere-like appearance. The few other cells of which the bands are made up are different in character, and are only arranged in double rows quite anteriorly.

The muscles in the cephalic region are altogether similar to those seen in *Polygordius*, and in addition to these we find on the whole of the inner surface of the body-wall a system of extremely fine muscular filaments, which are closely attached to the ectoderm, and are arranged partly in circular fashion and partly irregularly; these are shown, later on, to be very characteristic of the Echiurid larva.

* 'Claus' Arbeiten,' iii. (1880) p. 15.

By the aid of high magnification, it is possible to see in the hinder portion of the cephalic region a very delicate longitudinal canal—the head-kidney; this runs for the greater part of its course parallel to the ventral longitudinal muscle, and opens ventrally at the anterior end of the mesodermal band, where its lumen is continuous with a fine pore in the ectoderm. Anteriorly, this excretory organ terminates in a small solid swelling, which is distinguishable by its clearer appearance from the dark granular protoplasm of the walls of the canal. The termination would appear to be formed by a single cell, and the rest of the canal by a very small number of cells.

The point to be noted in the older examples of the same stage is chiefly the great increase in the size of the trunk; this affects chiefly the mesodermal bands which, growing rapidly, get their cells arranged in two, then in several rows, and, in time, in two layers. Of other characters, the most important are the appearance of a pre-anal circlet of cilia, not hitherto distinctly seen in the larva either of Mollusca or Rotatoria; the pre-oral circlet gradually becomes reduced to one row; the cells which form the inner layer of the integument become considerably modified; at first connected with one another by numerous processes, they become in time converted into a membrane, which forms an internal sac; a secondary branch is developed on the kidney, and in time the primary one is atrophied.

The characters of the *second* period are shortly summed up in saying that the increase in size is still chiefly seen in the region of the trunk; the mesodermal bands become further developed in the characteristic Annelid mode; starting from before backwards they give rise to the primary segments. In these there appear cavities which are due to the separation of the entero-muscular from the dermo-muscular layer. It is at this period that the œsophageal commissures and the lateral ganglia of the ventral cord begin to be developed, and that we see the first appearance of the ventral setigerous sacs; these are placed in the first trunk-segment, and at the sides of the ventral longitudinal muscles.

In the *third* period the process of segmentation comes to an end, and the separate segments all take very much the same appearance. Metamerism is very clearly shown, internally, by the appearance of segmental ciliary circlets, and (later on) by the peculiar arrangement of the pigment. At the same time we find that the internal dissepiments, which primitively divided the secondary cœlom into segmental cavities, are converted into filaments, and are gradually replaced by a tissue of ramifying cells which extend between the dermo-muscular and the entero-muscular plates. Nor can any very distinct indications of segmentation be said to be afforded by the ventral ganglionic cord.

Turning to the development of the setæ, we find that their sacs have been growing inwards towards the cœlom, and transverse growths give indications of the muscles of the setæ; internally a small cavity is formed, and at its base there appears a small, highly refractive corpuscle, which is the tip of the seta. This grows broader, and elongates; its cavity is still hollow, its chitinous walls show signs of a longitudinal striation, and it is soon possible to detect a striation of its epithelial cells. The terminal kidneys are also appearing; these are not developed, as has been often supposed, from the rectum, but in a similar fashion to the other segmental organs, and, as they belong to the terminal segment, their mode of development has an important bearing on the theory of metamerism. Other points must be passed over to bring us to the next stage in which the larval characters begin to lose their importance, and the creature commences to take on the more definite characters of the *Echiurus*. As these processes are being completed the ciliary circlets get lost, while blood-vessels and dermal papillæ begin to appear. In the last larval stage we have distinct, though young, *Echiuri*.

*Theoretical Considerations.*—The author is of opinion that the history of development, as he has observed it, is conclusive as to the Annelidan affinities of *Echiurus;* and, as this genus has very distinct relations to the other chætigerous Gephyrea, *Thalassema* and *Bonellia*, he believes himself justified in extending his generalizations to the whole of the Echiurida. Every point of importance in development is Annelidan, but we have further to recognize that, owing to adaptation to special modes of life, the Echiurida are modified forms. The next question is, of course, are their relations to the Archiannelides closer than they are to higher forms? and here their complicated organization and the presence of the characteristic setæ enable us to answer it in favour of their nearer relationship being to the Chætopoda. Further consideration leads us to see that by the presence of a proboscis, the absence of distinct dissepiments, the reduction of the setæ and of the segmental organs, together with such important points as the extension of the post-oral region and the characters of the terminal segments in which there is an organ homodynamous with a segmental organ, the Echiurida have undergone a wide divergence from the primitive type.

As to their relations to the non-setigerous Gephyrea (Sipunculids, &c.), the author is not completely satisfied, and waits for embryological investigations to say whether some of their characteristics are due to genetic relations.

The *Annelides* may now be thus arranged:—

1st Class. Archiannelides (*Polygordius*).

2nd Class. Chætopodes.

  1st Order. Saccocirridæ.

  2nd „ Polychætæ.

  3rd. „ Echiuridæ.

  4th. „ Oligochætæ.

3rd Class. Hirudinea.

Appendix (4th Class). Sipunculacea.

As to their bearing on the Trochophore-theory, the author is of opinion that the present results bear out fully the doctrines on which he has previously insisted; while as to the theory of segmentation, he points out that in the Mollusca there is a similar distinction between head and trunk, but that no metameric differentiation is to be made out in the latter. In the lower Bilateria the chief organs of animal life are confined to the anterior portion of the body, while the hinder part contains the generative organs. But, nevertheless, it is only gradually that the head takes on the higher sensory functions and becomes sterile. At first it is the head which is the largest part of the body; in the trunk, differentiation commences in the anterior portion, and growth is terminal. This is the typical mode of growth which leads in time to the typical metameric animal.

**Excretory Organs in the Trematoda and Cestoida.***— M. Fraipont has a fuller paper on this subject,† which is illustrated by two plates.

In dealing with the morphology of the excretory system in the Vermes, he points out that, on a comparative examination, there are two types of renal organs. In the Turbellaria, Nemertinea, Cestoida, Trematoda, and Rotifera, there is a system of canals, with walls, which are probably glandular, and which open into the cœlom by a number of ciliated infundibula, and are connected with the outer world by a single and median, or by two lateral vesicles. On the other hand, in the Annulata (Hirudinea, Oligochæta, Chætopoda) there are true segmental organs (nephridia—Lankester) which are always multiple and paired. In the Gephyrea both sets of organs appear to be present.

Coming to closer details, it is possible to detect in the Trematoda:—

(1) A terminal vesicle, posterior in position; or two vesicles, ventral and anterior.

(2) Into this there open by two trunks a system of large canals.

(3) These canals communicate with lymphatic spaces by ciliated infundibula.

(4) From these, canaliculi pass into the larger canals.

Practically similar arrangements are to be seen in the Cestoida; but it is to be noted that in some, at any rate, of the forms which exhibit a segmentation there are a number of pores communicating with the exterior; and this is of interest as pointing to the mode by which in the Annulata a number of organs may have become developed.

In the Dendrocœlous Turbellarians, Hallez has denied the presence of an excretory apparatus, but the observations of Schmidt, Schultze, and Kennel would appear to make its presence almost certain. Notwithstanding contradictory statements, an arrangement is also to be found in the Nemertinea (especially *Malacobdella*) which is exactly formed on the same type as in the Rhabdocœla.

In the Rotifera we again find an organ formed of three constituent parts: (1) a terminal vesicle, single or double, and ordinarily placed at the hinder end of the body, (2) two large lateral trunks, with a glandular wall, and (3) small canaliculi which open into the general cavity of the body by one or more ciliated infundibula. This general concordance in structure is in striking agreement with the well-known views of Professor Gegenbaur.

* 'Arch. de Biol.,' i. (1880) p. 415.

† See this Journal, *ante*, p. 802.

Can we find in the anal vesicles of the Gephyrea a resemblance to the excretory organs of the Rotifera? The investigations of Lacaze-Duthiers on *Bonellia viridis* have shown that there are two large contractile vesicles opening into the cloaca; into these vesicles open tufts of ramified tubes which open by their end into the cœlom by ciliated infundibula; the author remarks that in *Echiurus* this arrangement is less well developed,* and that in *Sipunculus* it is reduced to the rudiments of the vesicles. On the other hand, *Sipunculus* has a pair of true segmental organs, while *Bonellia* has none at all. In *Thalassema* and the Echiurida there are two or three pairs of segmental organs.

In the Hirudinea the primitive excretory apparatus seems, at least during development, to make a last appearance, while it completely disappears in the Annelides. Are the permanent renal organs of these Annulata the homologues of the apparatus found in the more lowly worms? This does not seem to be yet certainly established, for we have (1) the presence of both sets of organs in some adult Gephyrea, and (2) in the Hirudinea the two sets, one of which disappears very early, appear to have an independent origin.

The author is not inclined to accept Professor Haeckel's division of the Vermes into Cœlomati and Acœlomati; as to the latter, he points out that there are spaces in the connective tissue of the Trematoda, and that into these the ciliated infundibula open; these lacunæ may further vary greatly in extent; this is true of the terrestrial Planaria, where Moseley has discovered longitudinal spaces on either side of the body, and of the Nemertinea, where a cœlomatic space has been observed by Macintosh and Hubrecht to surround the digestive tract.

In a note presented to the Academy of Brussels,† M. Fraipont states that he has been able to extend his observations to *Distomum appendiculatum* (which lives in the intestine of *Gadus morrhua*), and finds it to be provided with ciliated infundibula, exactly comparable to those of *D. squamula*. *D. divergens* has, it is interesting to note, two infundibula terminating each canaliculus, and that in the place of one. A young living *Tænia echinococcus* has, in addition to the four longitudinal canals, a system of fine canaliculi, a certain number of which terminate by small ciliated infundibula, similar to those of *T. serrata* and *T. cucumerina*. *Bothriocephalus infundibuliformis* (from the pyloric appendages and intestine of *Trutta trutta*) has a very complicated system of canals. *Tricuspidaria nodulosa* (from the intestine of *Esox lucius*) has a plexus of very fine canaliculi, from which there arise small branches which are provided at their free end with a ciliated infundibulum.

**Ciliated Embryo of Bilharzia.**‡—The ovum of this little-studied entozoon presents, according to M. J. Chatin, a regularly oval shape, and a smooth external contour, and has a conical prominence at one of its poles. Segmentation is rapid, and results ultimately in the forma-

* See this Journal, *ante*, p. 134.

† 'Bull. Acad. R. Sci. Belg.,' xlix. (1880) p. 106.

‡ 'Comptes Rendus,' xci. (1880) p. 554.

tion of an embryo covered with a well-ciliated cuticle. A kind of proboscis indicates the future cephalic region. No differentiation takes place internally, as a rule, until the extrusion of the egg. After this has occurred, a cæcal depression commences to form below the proboscis, and extends vertically into the body. It grows considerably, and throws out a number of secondary diverticula, which form an elaborate network, of vascular appearance, at different parts of the body, especially in the tegumentary layer. At the same time appear in the posterior region some usually spheroidal bodies, which increase in number and bulk, and contain nitrogenous, glycogenous, and fatty materials. They are probably gemmæ formed within the embryo; for when they are fully formed, it becomes disintegrated and sets them free, when they move about with rapid contractions in the surrounding medium.

The nature of the ovum, as here set forth, shows this animal to rank, at this stage, above all the other members of its class; for the cæca which it possesses represent the beginning of a digestive apparatus, and the vascular tree represents an excretory organ, while the contractile gemmæ are an entirely new factor in the anatomy of the group.

**New Type of the Cestodes.***—M. Moniez, impressed with the necessity of a comparative study, has of late largely devoted himself to these forms, and he has been rewarded by the discovery of a new type, to which he gives the generic name of *Leuckartia.* It is an unarmed Bothriocephalid, with both ventral and lateral genital organs. It was found in the pyloric appendages of a salmon, from an unknown locality.

Among the interesting points discussed, special attention is due to the account of the nervous system, which, as is well known, is so difficult to make out distinctly in these worms. Here it is easily seen. It does not, however, seem to persist for a long period, but to early undergo a kind of fatty degeneration; so that it is, therefore, best studied in young joints. The author believes that Sommer and Landois have mistaken for nerves the outer of the two blood-vessels which they describe. In *Bothriocephalus latus* (old joints) the nervous cords are, owing to the great development of the spermatozoa, pushed to the ventral surface, and it is very much this position that the German helminthologists give to their outer vessel.

With regard to the systematic position of *Leuckartia*, the author points out that, with the exception of *Triænophorus*, the Bothriocephalida have the genital orifices ventral in position, and have two suckers, while the Tæniadæ have the genital orifices lateral and have four suckers. The new genus belongs to the former group, for *B. proboscideus* (as figured by Blanchard) has both lateral and ventral genital organs.

**New Cestodes.**†—M. Moniez describes a new species of *Tænia*, from the intestines of the wild rabbits at Wimereux, under the name of *T. wimerosa.* It is about 1 cm. long by $1\frac{1}{2}$ mm. broad. The head

* 'Bull. Sci. Dép. du Nord,' iii. (1880) p. 67. † Ibid., p. 240.

is large, with well-marked suckers, but no hooks or neck. The lower edge of the segments is very distinct, rounded, and bears a row of filaments resembling those of the suckers of *Ligula.* The genital apparatus is single, and occurs on the same side in all segments, the female opening on the inferior edge, the very prominent penis in the middle of each. The penial sheath early occupies most of the segment, but is ultimately absorbed, owing to the development of the ova. The ova resemble those of the *Tæniæ inarmatæ.*

In considering the development of the Cestodes, M. Moniez points out that the imperfect segmentation of the ovum, as shown by *Tænia serrata* and *expansa*, is by no means the rule in this group. And in these cases the extruded cells do not aid in the formation of the cells of the blastoderm, but they are the homologues of the polar corpuscules, and only occur when these are wanting, and *vice versâ.* The true relations of the extruded cell are seen clearly in a new species of Cestode, found at Wimereux, in *Squatina angelus.* Here the original egg-cell, after dividing into two, becomes distended with liquid, and ascends to the surface of the yolk, and is usually destroyed shortly. On the other hand, the primary cell is detached in the form of an ordinary polar vesicle in species such as *T. anatina*, &c., in which the segmentation appears to be regular; or else it persists, and increases greatly in size (in *T. serpentulus* and others), in which case, the blastodermic cells surround it, and may even conceal it, after giving the embryo the appearance of being hollow. In a *Bothriocephalus* inhabiting the salmon, these processes are exactly like those of *Ligula*, except that the embryo is developed within the parent, and that the amnion, corresponding to the embryophore, is granular, and shows no analogy with the corresponding membrane in *Ligula.* The embryo is seen in *Tænia serpentulus*, and less distinctly in *T. cucumerina*, gradually to become hollow. Two muscles, strongly refractive in appearance, are especially noticeable, passing backwards from the cephalic bulb, to become attached at the posterior end of the cavity thus formed.

The segmental organs of the Cestoidea are not the organs described by Fraipont as such, but, as is the most clearly seen in *Leuckartia*, consist of the so-called *vagina*, which opens at one end into the uterus, and at the other into a wider chamber connected with the ova. This chamber has proper muscles, is attached on all sides to the surrounding tissues, and the cells which line it contain a coloured material; the tube leading to it is ciliated throughout. It thus fulfils all the requirements of a typical segmental organ; and it is known to exist in this form in the higher *Tæniæ.*

**Solenophorus megacephalus.***—M. Moniez in this note criticizes the account given by M. Poirier.† The later observer has only been able to detect two (one on either side) in place of six longitudinal vessels. Without dealing with any points in discussion between these two naturalists, it is of importance to direct attention to the explanation which M. Moniez gives as to the very different accounts of various observers. As in all the lower animals, there

* 'Bull. Sci. Dép. du Nord,' iii. (1880) p. 113.

† See this Journal, ii. (1879) p. 284.

appear to be all kinds of grades between distinct vessels with complete walls, and those which may almost be regarded as lacunæ. Moreover, there are examples of central vessels which give rise to largely anastomosing peripheral branches; and these (as in *Leuckartia*) may even penetrate into the meshes of the fundamental tissue. Injections might, of course, give rise to the appearance of vessels in cases such as these. The author further directs attention to the great development of the marginal fold of each joint in *Solenophorus.*

**Histology of the Tetrarhynchi.***—Herr Laczko says of the "knobs" of the proboscis of these forms that they are provided with two muscular layers. One is very thick on its outer surface, and forms a layer of longitudinal fibres, arranged in three groups. The other, external to this, consists of a double layer of diagonal fibres. In addition to these, there is also a circular layer, the fibres of which are thick. The retractor proboscidis arises independently from the most posterior portion of the wall of the knob, and gradually decreases in width as it passes forwards. The nervous system appears to be exceedingly well-developed. On both the ventral and the dorsal sides there is a well-developed layer of ganglionic cells. These are unipolar, of considerable size, and provided with a distinct nucleus. The processes which arise from them, and which may be twice or thrice as long as the cell, have their long axis in a line with that of the muscular fibres. It is clear, therefore, that we have to do with a cephalic ganglion formed of typical, large, unipolar ganglion cells, which give off two columns of ganglionic substance to the knobs of the proboscis, and also send branches to the suckers.

### Echinodermata.

**Viviparous Chirodota.**†—Dr. Hubert Ludwig directs attention to the rediscovery of Oersted's *Synaptula vivipara* (the *Chirodota rotifera* of Pourtalès). Dr. Ludwig's example was obtained by Professor E. van Beneden from the Brazilian seas. In the body-cavity, an l quite free, he found sixteen young, all considerably developed. No indications could be made out of the way by which they would pass to the exterior. The specimens were so well preserved that the author has been able to make a complete anatomical investigation, which he promises to publish shortly. The attention of American naturalists to the subject will probably lead to important results.

**Observations on the Temnopleuridæ.**‡—The greater part of Professor Bell's paper on these regular Echinoida is occupied with an account of the measurements of the more important parts of the tests of these creatures; the diameter being given in absolute measurements, the percentage values of the measurements of the height, the abactinal area, the anal area, and the actinostome are given in percentages. "Two recommendations," the author says, "present themselves for undertaking this exceedingly laborious task: the changes which occur during growth are at once seen; and secondly, an aid is given to that

* 'Zool. Anzeig.,' iii. (1880) p. 427. † Ibid., p. 492.
‡ 'Proc. Zool. Soc. Lond.,' 1880, p. 422. (1 plate.)

not small group of naturalists who have not under their hands so large a series of forms as is fortunately to be found in our own national collection. Differences in proportion will not now form the chief ground on which new species are established; and the value of the British Museum series will be hereby extended to those naturalists who, for want of such, are naturally enough led to regard their single immature specimen as the representative of a new species."

In dealing with the genus *Amblypneustes* Professor Bell points out that, in the case of *A. griseus* and *A. formosus*, it is possible to detect two very distinct series for each species; taking the former, we find that there is one series with a small actinostome, a small abactinal area, and a rather wide poriferous zone; the other has the actinal and abactinal areas very much larger, and the poriferous zone somewhat narrower; these characters are shown by the table of measurements; with them, however, there are associated two others, "those with the small actinostome have much larger genital pores and the madreporic plate is much more prominent." In dealing with *A. formosus* the author enters into greater details as to the sizes of the genital pores, and illustrates his results by showing, by the aid of four entomological pins, of various calibres, how these small orifices may vary in size. He propounds the possibility of the two series being, in each case, different sex-forms of the species, and looks to those naturalists who can get fresh specimens, for a definite resolution of the question. In dealing with *Salmacis globator* he points out that two very distinct forms appear to have had this name given to them, but he refrains from naming at the present either one or the other, and contents himself with giving a description of the two, and figures of them both. He hopes that Professor Alex. Agassiz will be able to set this matter right, as he and his father are the only two naturalists who have given original descriptions of the species.

With regard to changes during growth, one or two examples will show how marked this may be; if we take *Temnopleurus Hardwickii* we find that a specimen 7 mm. in diameter has an anal area 14·28 per cent. wide and an actinostome 42·8 per cent. wide, while one 43 mm. in diameter has the same parts 9·02 per cent. and 26·7 wide; while *Salmacis sulcata* has, with 14 mm. for diameter, an actinostome of a width 42·8 per cent., and when the diameter is 59 mm. the percentage value of the width of the actinostome is only 26·6.

**Abnormal Echinids.***—Professor Jeffrey Bell and Mr. Charles Stewart direct attention to two cases of abnormalities in these forms; they are both exhibited by specimens belonging to the Temnopleurid genus *Amblypneustes*, and are, when taken together, interesting as pointing in opposite directions; so far that is, that one describes a quadriradiate and the other a sexradiate variation from the ordinary pentamerous arrangement.

Mr. Stewart's specimen, which was from his own cabinet, and belonged to *A. griseus*, is remarkable for having "a crest-like elevation of what appears to be one of the ambulacra"; this crest is shown to

* 'Journ. Linn. Soc.' (Zool.), xv. (1880) pp. 126–9. (1 plate.)

be formed by two ambulacra which lie side by side; the poriferous zones which touch one another are fused together; the other zones and the ambulacral areæ are normal in character. In this form the apical system was normal.

The other specimen is in the collection of the British Museum, and was one of the examples of *A. formosus* which were brought home by the 'Challenger.' In it no indications of the fifth segment of the corona are to be observed except on the actinal surface, but there are no indications of the interambulacral plates; just as in *Echinus melo*, the only other recent species in which a similar abnormality has been noted (Philippi), it is the left anterior area which has suffered the injury; the abactinal regions, in these two specimens, differ so far from one another, that in Phillippi's specimen there was a tetramerous arrangement, while in the British Museum specimen all the ten plates are still present; but this latter differs again from Mr. Stewart's example in having an ocular plate considerably enlarged. Professor Bell imagines that "had its capture been a little delayed, the plates of the fifth segment or area might have been completely forced off." A purely tetramerous test has, he observes, been found fossil; this, described by H. von Meyer, belonged to the species *Cidarites coronatus*. The author concluded by insisting (1) on the fact that deviations from the pentamerous type seem, in the Echinida, to be due to abnormalities, and (2) on the striking constancy which is exhibited by these forms, as compared with Asterids or Ophiurids.

**Remarkable Form of Pedicellaria.*** — Mr. Sladen gives in a tabular form the "synonymy" of these organs:—

| O. F. Müller (1778). | | Valentin (1841). | | Perrier (1869). |
|---|---|---|---|---|
| *P. globifera* | = | *P. gemmiforme* | = | *P. gemmiforme* |
| *P. triphylla* | = | *P. opicéphale ou buccale* | = | *P. ophicéphale* |
| *P. tridens* | = | *P. tridactyle* | = | *P. tridactyle* |

In *Sphærechinus granularis* the pedicellariæ globiferæ are very much larger than the rest and are, as compared with the same organs in other Echinids, enormous; upon their stem or pedicle there is situated, between the middle portion of the shaft and the distal end, a remarkable glandular organ; it is divided into three separate sacculi, and near the upper portion of each there is a small foramen through which a glairy mucus is extruded; this extrusion is mostly easily observed when a specimen is placed in fresh water. Each sacculus is, on examination, seen to contain an "elongate-ovate or sub-cordiform mass"; when seen separately this mass is found to consist of a "white, spongy, reticulated substance with a denser central portion within and a number of moderately large pink cells distributed over its surface," external to the general mass. Sections are best made after a preliminary decalcification in a solution of 70 per cent. alcohol with 2 per cent. of hydrochloric acid, and staining in hæmatoxylin. Transverse sections made through specimens thus prepared show the presence of (1) the epithelial nucleated cells of the investing mem-

* 'Ann. and Mag. Nat. Hist.,' vi. (1880) p. 101.

brane; (2) a neuro-muscular layer; (3) a tissue with numerous large cells; (4) a layer of large areolar spaces and gland-cells and ducts; (5) the central mass composed of a very finely reticulated substance, densely filled up with mucous matter.

As to the characters of the "head" of the *P. globifera;* a longitudinal section reveals the presence of the following parts:—(1) a fine investing membrane, composed of a few epithelial cells. (2) A stratum containing a few nerve-cells. (3) The walls of a large saccular body bounded by a moderately thick layer of horizontally disposed muscular fibres. (4) A reticular tissue terminating in follicular gland-cells, which form a layer internal to the wall of the sac, and of some considerable thickness; the glandular sac is divided into two chambers. Nerve-centres with fibres for each valve communicate with the strong muscles which hold together the valves of the pedicellaria. On the inner surface of the expanded valves there are to be found three oval-shaped cushions, which are finely papillate and are richly provided with nerve-fibres.

In regard to the suggested functions of these parts we find first of all this notable discharge of mucus; "when the tactile cushion of the pedicellaria comes into contact with a tangible object of foreign matter, the valves close and a discharge of mucus takes place"; this mucus surrounds the object and then the neighbouring spines gradually disentangle it, and the currents of water carry it off. The author has made observations on *Astropecten aurantiacus* which strongly confirm this view.

Mr. Sladen then gives a short account of the structure of the same kind of pedicellaria in *Echinus melo*, which seems to resemble the younger forms found in *S. granularis.* The pedicellariæ tridentes appear to have the function, already noted by A. Agassiz, of removing the pellets of fæcal matter; that of the *P. triphyllæ* is probably to seize smaller particles of foreign matter which escape the larger pedicellariæ.

**New Echinodermata.***—In addition to *Hymenodiscus Agassizii*, referred to in the next note, M. E. Perrier describes some very interesting forms obtained during the dredging operations of Professor A. Agassiz in the deeper parts of the Gulf of Mexico; among these are two new species of the genus *Zoroaster* of Wyville-Thomson (*Z. Sigsbeii* and *Z. Ackleyi*).

*Z. Sigsbeii* is at once distinguished by the considerable projection made by the enormous ossicles of its disk, which is thus rendered clearly distinct from the arms and comparatively voluminous. The arms, which are nearly rigid, are conical, and their skeleton consists of nine regular series of square ossicles. In *Z. Ackleyi* the ossicles of the disk are not salient, the disk is continuous with the arms, which are about twelve times as long as its radius, so that the animal has the physiognomy of a *Chætaster*. These arms are much more mobile than those of the other species, and are formed of seventeen rows of rather small ossicles. In the two species before the author the plates

* 'Comptes Rendus,' xci. (1880) p. 436.

of the ventral region of the arms are covered with small flattened spines placed close together and intermixed with larger spines, so as to recall to mind the covering of the ventral surface of the *Luidiæ;* the adambulacral plates even bear, as in the latter, a comb of compressed spines, the direction of which is perpendicular to that of the ambulacral groove and the innermost of which is recurved like a sabre, as in the Astropectinidæ. The ambulacral tentacles are quadriserial at the base of the arms, but biserial at the extremity, which is an additional proof how artificial is the old division of the Asteriæ adopted by Müller and Troschel. These tentacles are terminated by a very small sucking disk which still further approximates *Zoroaster* to *Luidia;* they are intermixed with small straight pedicellariæ (*pédicellaires droites*). We may give the same name to some of these organs disseminated between the dorsal plates.

**Synthetic Starfish.**—At p. 448 was noted an interesting form of starfish, apparently bridging over the gap between the Stellerida and the Ophiurida, which had been described by Mr. W. Percy Sladen. M. E. Perrier now describes * a still more remarkable type obtained from the Gulf of Mexico during the dredging operations above referred to.

This starfish is very delicate in its structure; it has a rounded disk distinctly separated from the arms, as in the Ophiurida, and the arms are elongated, flexible, and furnished with lateral rows of spines, thus increasing the general resemblance to the Brittle-Stars. But there are twelve arms, whilst no known Ophiurid has more than seven. The description of the disk is very curious, and nothing like it is known elsewhere among starfishes. It is flattened, very thin, and quite destitute of any regular skeleton, the dorsal membrane being in fact literally a circular membrane stretched upon the ring formed by the basal ossicles of the arms; it is membranous and transparent, and so close to the buccal membrane that the stomach has only a space about equal to the thickness of a sheet of paper in which to lodge. M. Perrier very justly asks what can be the usual food of an animal with such a digestive cavity? The dorsal skeleton is, however, represented by scattered perforated calcareous plates, each bearing a small spine. Through the membrane the circular canal surrounding the mouth, and the ambulacral vessels starting from it, may be recognized, but no cæcal prolongations of the stomach into the arms were to be detected. The arms possess a double row of ambulacral tubes, but no genital glands could be discerned in them. The skeleton of the arms consists of four rows of pieces, two of which form a dorsal ridge, and partially cover the others, which are placed on each side, and each of which bears a median spine enclosed in a soft sheath, clavate, and bearing at the apex a tuft of pedicellariæ, the latter being of the kind denominated "pédicellaires croisées" by M. Perrier, and peculiarly characteristic of the Asteriadæ, the most typical group of the true starfishes. The lateral plates form the borders of the ambulacral groove, in which the ambulacral vessel rests exactly as in the

* Loc. cit. See 'Pop. Sci. Rev.' (1880) pp. 380-1.

Comatulæ, there being no ambulacral plates, such as occur in all known Stellerida.

M. Perrier remarks that the contrast between the arms and the disk, the probable absence of genital glands from the arms, and the absence of stomachal cæca, would seem to approximate this form to the Ophiurida, just as the structure of the arms would ally it to the Comatulæ; but although in the abnormal characters above cited, and especially the want of ambulacral and buccal plates, it differs from all known Stellerida, the evidence of the pedicellariæ leads him to class it in that group, as forming an aberrant family of the Asteriadæ, in the neighbourhood of the genera *Labidiaster*, *Pedicellaster*, and *Brisinga*, which also possesses only two rows of ambulacral tubes.

M. Perrier names this singular starfish *Hymenodiscus Agassizii*. It was obtained within sight of the island of Dominica, from depths of 321 and 450 fathoms.

**Formation of the Egg-covering in Antedon rosacea.***—Dr. Ludwig states that a short time before the extrusion of the ovum there is to be noted, on the aboral surface of the pinnulæ, a small circular projection, distinguishable by its whitish colour; if we open a pinnula at this stage and examine the ova we find a special disposition of their surface. The whole egg appears to be invested by a network, the bars of which are darker than the circular meshes. Further observation shows that this network owes its origin to a special development of the investment of the ovarian cell and of the cell itself, for the investment is, on its inner surface, villous, and the villi project into the yolk-spheres of the egg, so that the rounded clear spaces, already noted, are merely the optical section of these villi. When the eggs have been for some time subjected to the action of sea-water we find that the surface of the egg has become plane, and has got itself invested by a thick shell.

## Cœlenterata.

**The Ctenophora.**†—This paper by Richard Hertwig occupies 135 pages, and is illustrated by seven plates. The more general results to which his investigations have led him are the following:—

*Structure of the Generative Organs.*—Do these arise from the ectodermal or from the endodermal layer? Among the later writers we find Claus on the one side and Chun on the other. Hertwig agrees with Claus in regarding them as having an ectodermal origin. The epithelium of the surface of the body projects into the ctenophoral vessels in the form of small saccules, which project into the gelatinous layer, and reach as far as the endodermal epithelium of the vessels. Here they broaden out and form two epithelial layers, which are separated by a cleft, the genital sinus. The layer which bounds the endodermal epithelium forms the generative products. As there are no blood-vessels, the tissues which require a rich supply of nutriment are developed in close connection with those branches of the enteric

* 'Zool. Anzeig.,' iii. (1880) p. 470.

† 'Jen. Zeitschr. Naturw.,' xiv. (1880) p. 313.

canal which are richly supplied with chyme. It is probable that the ctenophoral vessels of the Ctenophora, which are comparable to the radial canals of the Medusæ, were, like them, primitively placed just below the ectoderm, and that they owe their changed position to the development of gelatinous matter in the disk. In their change in position they would seem to have been accompanied by the genital organs.

*Structure of the Neuro-muscular System.*—After a short account of the investigations of earlier observers, and a somewhat more detailed notice of those of Eimer, the author states that in general he finds himself in agreement with the latter. He is of opinion that there is a true nervous system, the elements of which are to be found in the gelatinous layer; and he considers that they are diffused through the body and do not exhibit any distinct centralization. Such physiological observations as he has been able to make are found to be in concordance with the results of Eimer. At the same time the agreement is only of the most general character. The varicosities which Eimer regards as forming structures allied to ganglionic cells are regarded by Hertwig as being artificial products. Yet again, Eimer finds no nerves in the ectoderm, while Hertwig believes that he has found a well-developed nerve-plexus in that layer.

The author next compares his results with those of Chun, and then proceeds to say that the nervous system of the Ctenophora consists of an ectodermal and a mesodermal portion. The former has the character of a ganglionic plexus which lies just below the epithelium and is equally distributed over the whole surface of the body. In *Beroë* it may also be followed on to the stomach, where it takes up a position between the gelatinous and the muscular layer, in consequence of the great development of this latter. Only a small number of nerve-fibrils are given off, and these branch and anastomose very considerably. Nowhere in the plexus is there any indication of a commencement of any centralization. From *à priori* considerations it is to be imagined that there is some connection between the elements of the plexus and the sensory cells of the auditory vesicles and the polar areas, but this has not yet been demonstrated. In no one case was it possible to detect nervous processes passing to the cells. The same is true as regards the tactile cells, which are found everywhere in the epithelium, and especially in the region surrounding the mouth in *Beroë*. The tentacular apparatus forms a special division of this neuro-muscular system. The ectodermal muscles are here of enormous length, and pass at their base into epithelial cells. To the surface of this layer they are set perpendicularly.

The mesodermal portion of the nervous system would appear to consist of a very large number of very delicate fibres, which are, at points, provided with spindle-shaped nuclei, and are invested in a neurilemma. Like the muscular fibres, they pass separately into the gelatinous layer, and end by branches in the epithelium. The processes by which they are connected with this layer are probably derived from the ectodermal plexus, but of this there is no certain evidence. There does not seem to be any regularity in the mode of the distribution of the nerve-fibres in the gelatinous layer, the only constant character being the presence of the eight branches which underlie the meridional bands. There are very various reasons for regarding these elements as belonging to the nervous system: the vital phenomena of these animals require it; their histological structure is very similar to that of the nerves in other Invertebrata; and their mode of connection with the muscular fibres has a very striking resemblance to what has been observed in the Tardigrada. On the other hand, the nerves of the higher animals arise from the central organs in the form of filaments of considerable thickness, and they branch, as they pass peripherally, until they end in a sensory organ or a muscular fibre. This is not the case with the nerve-fibres of the Ctenophora; they are branched at both ends, and the terminal filaments never enter muscles, into which there only pass small lateral branches.

On the other hand, if these filaments are not nerves, can they be muscles? Hardly so, for in that case *Cydippe hormiphora*, at any rate, would have muscles of the ordinary histological character, and these very special muscles also. Nor can they be a part of the supporting system of fibres, for the fibres that have distinctly a supporting function have no nuclei, and never become connected by anastomosis with one another.

We come, then, to the conclusion that the filaments which are distributed through the gelatinous layer of the Ctenophora have no close resemblance to any elements found in higher animals, but that they are best compared with the nerve-fibres of the Invertebrata. On the physiological side their nervous function is very distinctly spoken to.

*Relations of the Ctenophora to the other Cœlenterata.*—The author regards these forms as being very distinct from the rest of the group in which they are placed. To decide the questions which have been raised with regard to this subject, we have, first of all, to inquire whether in the developmental history of the higher animals there is any stage which is comparable to that which is permanent in the Ctenophora. The nervous system of most of these, at any rate, is situated in the mesoderm; the same is true of these Cœlenterates. But now it has to be seen whether this system, derived in both cases from the ectoderm, is in the first stage scattered through the mesoderm and only secondarily concentrated. This, of course, is not the case. Where the nervous system remains ectodermal in position, as it does in some of the higher Metazoa, it is nevertheless even there concentrated. Eimer's hypothesis is hereby negatived.

Secondly, there arises the question, what relation have the neuromuscular cells of *Beroë* to those of *Hydra?* The only point of resemblance is that mode of continuous connection between muscle and nerve which always occurs in all animals provided with these structures; otherwise there is nothing in common. The neuro-muscular cell of *Hydra* is an ectodermal, the neuro-muscular fibre of *Beroe* an endodermal structure. The sensory cells only become connected with the latter in a secondary fashion.

The author then shows how the neuro-muscular systems in the

Hydroida and Anthozoa on the one hand, and the Ctenophora on the other, are to be regarded as having been developed along two different lines, having their point of union in a common ancestor. In the Actiniæ and Hydroida the nerves and muscular fibres are developed in the epithelium. Some epithelial cells give off muscular fibres at their basal ends, while others form processes and become converted into sensory cells or epithelio-ganglionic cells. When most completely developed, these pass from the surface of the body and go to form subepithelial muscular cells or ganglia. Wherever nervous elements are found in the mesoderm, they are only migrated organs. In the Ctenophora the corresponding mesodermal parts do not arise *as such* in the ectoderm, but they there only form indifferent amœboid cells, and they undergo their further differentiation after that they have changed their position. In connection with this important difference there is yet another, which is to be found in the histological characters of the mesodermal muscular fibres. In the Actiniæ and the Medusæ there are bundles of muscular fibres grouped around a protoplasmic multinucleated axis; in the Ctenophora the muscular fibres are all of them elongated multinuclear cells, which have arisen from the growth of a single uni-nucleated cell, and which are invested by a covering, which is not made up of separate fibrils.

Led by these facts, the author has come to the conclusion that the Ctenophora have arisen from very "indifferent" primitive forms, in which the only indication of the characteristics of the Cœlenterato phylum was probably the tendency to a radially symmetrical arrangement of the organs. Even the prehensile cells are so different that it is hard to imagine that they had the same origin as the parts which are regarded by Professor Haeckel as being homologous with them in the other Cœlenterata ("stinging-cells"); and Hertwig holds that the Ctenophora are but very distant allies of the rest of the Cœlenterata.

*Preparation.*—Osmic acid was used as a hardening material, carmine as a colouring. For maceration purposes a solution of ·05 per cent. osmic acid, containing ·2 per cent. acetic acid, was used. No good results were gained by the use of chromic acid, bichromate of potassium, or gold chloride. Observations in the fresh state are of great importance.

*General View.*—Along the body of a Ctenophore three axes may be drawn. The longitudinal or primary passes from the oral to the aboral pole, and this is generally the longest; the transverse axis can best be made out in the tentaculate forms; the sagittal axis is perpendicular to the other two. No true right or left, dorsal or ventral surfaces are to be made out, but only an oral and an aboral end. The greater part of the body is gelatinous, and this portion is extraordinarily rich in water. The sensory body or "ganglion" and the polar areas are placed on the aboral side of the body, and the former exactly occupies the centre of the end of the primary axis. From the sensory body there arise eight ciliated grooves, which are continuous with the eight rows of ctenophoral plates; these form meridional bands. The most important parts of the gastrovascular system are the stomach and the funnel; the latter leads into the peripheral canal system, which consists of three sets of vessels. Then there are the tentacles, supplied by the tentacular vessels, and lastly, there are the generative organs which follow the course of the ctenophoral vessels, in the walls of which the products are developed.

There are well-marked differences between the three layers of the body. The *ectoderm* is the most widely distributed, inasmuch as it does not only invest the body, but also the stomach. It is, further, the layer which undergoes the greatest amount of differentiation, forming not only investing, but also glandular, pigment, ciliated and sensory cells, in addition to nerves and muscles. The most important organs are nothing but specially differentiated parts of the ectoderm.

The sensory cells are of two kinds, which so far agree in structure that they are always provided with stiff processes, which have evidently a tactile function. The most ordinary form of sensory cells is that which carries a number of small tactile processes. Of these there may be (*Eucharis multicornis*) as many as seven; others bear only one process, and that of considerable length and thickness. The author is confident as to the presence in the epidermis of a nervous layer. Other ectodermal structures must be here passed over, although they exhibit many points of considerable interest.

The *mesoderm* forms the great mass of the body. It is gelatinous, and in *Callianira*, *Eucharis*, and *Cydippe* is very soft, while in the Cestidæ and Beroidæ it is much firmer. It does not develop any supporting lamella, and although in itself completely structureless, it contains a number of variously differentiated cells. In *Beroë ovatus* there are found to be either muscular fibres, nerve-fibres, or connective-tissue corpuscles. Although these are, when most pronounced, easy enough to distinguish from one another, there are also others which seem to be intermediate in character. The muscles are either radial, circular, or longitudinal; each fibre consists of an axial and a cortical substance, together with a sarcolemma.

The *endoderm* is comparatively uniform in character. It would appear to consist of a single layer of epithelial cells, flattened on one side; the epithelium of the vessels is richly ciliated; distinct and well-marked stomata are to be observed, by means of which fluid can pass to the mesoderm, without any special modification of the endodermal cells being necessary. They are bounded by a rosette of cells which call to mind, by their arrangement, the structure of ciliated infundibula. No nerves or muscles were to be observed in this layer.

**Medusæ and Hydroid Polyps living in Fresh Water.***—Professor Lankester points out that the tolerance by marine animals of fresh water is a much more frequently observed fact in all classes, than the tolerance of sea water by lacustrine or fluviatile forms. It is undeniable that existing fresh-water forms have been developed by adaptation from marine forms, whilst it is difficult to cite any instance in which adaptation in the opposite direction appears to have taken place, some few marine Oligochætous Chætopods and Pulmonate Gasteropods being perhaps such instances.

* 'Quart. Journ. Micr. Sci.,' xx. (1880) pp. 483-5.

The tolerance by Medusæ belonging to marine species of fresh water under natural conditions was observed by Mr. H. N. Moseley, in New South Wales, and Professor Agassiz writes: "It strikes me as if the consequences resulting from the finding of the fresh-water Medusa* had been somewhat overdrawn. In the first place, we have two genuine fresh-water Hydroids, *Hydra* and *Cordylophora*, and in the second place, as far as my experience goes, it is not conclusive of so fatal an action of fresh water on Medusæ as Romanes would lead us to believe in. We have quite an estuary leading out back of Boston Harbour, extending on the one side to form what we call the back bay, and beyond this up the Charles River as far as Watertown, where there is a dam, about seven miles from the inner extremity of the harbour proper. Here the Charles River falls into this estuary as a fresh-water stream sufficiently large at times to affect the saltness of the estuary below it at low tide, so that at Cambridge, half way from Watertown to Boston, the water is salt only at the highest tides, quite brackish during the first half of the ebb, and comparatively fresh during the last part of the tide. At West Boston Bridge, about one mile from the head of the harbour, the water at the last part of the tide is fresh enough and tastes but little salt. At this bridge there is an abundance of Hydroids which thrive remarkably well on the drainage of the district, and grow to an unusually large size. The species found there which has no free Medusa is *Laomedea gigantea*; while of the Hydroids which have free Medusæ we find *Eucope diaphana*, *E. pyriformis*, and *Obelia commissuralis*. All these species are, therefore, twice during twenty-four hours exposed to salt water and to nearly fresh water, and thrive remarkably well under the treatment, as must of course their free Medusæ, which I have caught both at high tide and low water—in salt and in nearly fresh water.

Other of our Medusæ also find their way into this estuary, and I have found in fresh water, at low tide, active *Sarsiæ*, *Tiaropsis*, and also *Aureliæ*, which seemed unaffected by the large quantity of fresh water in which they were found."

**Origin of the Generative Cells in the Hydroida.**†—Dr. Weismann, in the paper referred to at page 813 (where the following should have been inserted) gives the results of his examination of *Tubularia mesembryanthemum*, *Eudendrium ramosum*, *Gonothyræa Loveni*, *Sertularella polyzonias*, *Plumularia setacea*, and *Aglaophenia pluma*. He confirms the fact that in some cases the eggs of the Hydroida are, without doubt, developed in the endoderm, while the seminal cells are by no means constantly developed from the ectoderm. Thus *Eudendrium*, *Sertularella*, and *Plumularia* have an endodermal origin for their sperm-cells, while *Tubularia*, *Gonothyræa*, *Campanularia*, *Hydractinia*, *Cordylophora*, and *Hydra* have the origin ectodermal.

In Hydroids with sessile buds, therefore, we find three combinations, out of four which are, in the nature of things, possible; (*a*) both sets of sexual products are developed in the endoderm (*Hydra*,

* See this Journal, *ante*, p. 652. † 'Zool. Anzeig.,' iii. (1880) p. 226.

*Cordylophora*, and *Tubularia*); (*b*) both arise from the endoderm (*Eudendrium*, *Plumularia*, and *Sertularella*); (*c*) the seminal arise from ectodermal, and the ovarian products from endodermal cells. It is interesting to note that no certain evidence is to hand of the fourth possible combination — the male elements being developed from the endoderm and the female from the ectoderm—ever having been correctly observed.

A further result of his observations is to be found in the fact that in several Hydroids the ovarian cells chiefly arise in the cœnosarc of the trunk, and only pass, during their growth, into the sexual knobs. This is, further, to be confirmed by a reference to the statements of Fraipont and of Van Beneden. The results of F. E. Schulze's researches on *Cordylophora* would seem to be explicable by supposing that he did not notice the very earliest stages, and that in *Cordylophora* the true seat of the origin of the cells is a portion of the cœnosarc which belongs to the gonophoral region.

**Development of Hydra.***—Herr Kerschner has a preliminary communication on the results he obtained, under the direction of Prof. F. E. Schulze. There does not appear to be any morula-stage proper. A blastula appears very early, and at its inferior pole, or that directed towards the parent, there is an invagination of cells, which go to form the endoderm. There is not, as Kleinenberg imagined, any conversion of the ectoderm into a chitinous investment for the embryo; but that layer does give rise to the connection between the mother and the embryo. The endoderm cells increase by the development of numerous protoplasmic connecting cords; and the lacunæ between them have a connective-tissue-like appearance, which only becomes altered by the closer approximation of the cells of this layer. The oral pole of the young *Hydra* corresponds to the vegetative pole of the ovum.

**Structure of Hydra.**†—Herr Korotneff finds that the epithelio-muscular cells of the "foot" are to be distinguished from the other ectodermal cells by their cylindrical form, their possession of a highly refractive fibrilla, and the presence in their superior third of a similarly refractive mucous secretion, by means of which the animal is enabled to attach itself. These elements he would propose to distinguish as glandulo-muscular. At the beginning of autumn the small, deeply-set cells of the ectoderm begin to proliferate actively, and, arranging themselves in groups, they push their way between the superjacent epithelio-muscular elements. These latter lose their nuclei, and become gradually absorbed. The cells thus lost are replaced by a number of small cells, arranged in several layers. The winter ectoderm cells, thus formed, undergo a fatty degeneration. In consequence of the destruction of the muscular system, the animal becomes considerably contracted, the endoderm gets folded, and the cavity of the animal completely disappears. The development of the ova has many points of resemblance to that of the ectodermal cells just described; but it only occurs at certain points. Here the lowest lying

* 'Zool. Anzeig.,' iii. (1880) p. 454. † Ibid., p. 165.

cells increase in size, their nuclei become converted into large germinal vesicles. One of these vesicles continues to grow, and becomes the definite germinal vesicle of the egg, while the other cells diminish, and go to form part of the investing cell-layer.

After describing the further details of the egg's growth, the author points out that in the course of its development there appear two directive corpuscles. The peripheral cells of the morula go to form the blastoderm-cells; the nuclei pass to the outer margin; the cells increase in length, and elongate in a radial direction. The endoderm is formed by cells which arise in the central portion of the morula. Two covering shells can be made out at about this stage. One is formed from the parent, and one is shed out by the egg itself. The latter, primitively simple, becomes thickened under the influence of external adverse conditions. It was this shell-layer which Kleinenberg regarded as the ectoderm of the embryonic *Hydra*. The internal cavity is formed by the centrifugal growth of the cells of the embryo.

### Porifera.

**External Gemmation in the Spongida.***—M. de Mereschkowsky directs attention to this mode of reproduction, which, as compared with the other asexual method (that of the formation of gemmules), has been but little studied; the process indeed seems to be rare, and has hitherto only been observed in the four genera of the family of the Suberitidinæ, *Tethya*, *Tetilla*, *Suberites*, and *Rinalda*.

After referring to the observations of Bowerbank and Oscar Schmidt, the author passes to the account which he has himself given of *Rinalda arctica* (from the White Sea); here he observed that the whole of the sponge was covered with long conical protuberances, hollow internally; buds became detached from these cones, and fixing themselves, gave rise to fresh sponges.

The observations now to be recorded were made on a species of *Tethya* from the same sea. This sponge is not more than one

---

EXPLANATION OF PLATE XXI.

(Figs. 1–5 are natural size, Figs. 6–8 × 7, Figs. 9–11 × 40, Figs. 12, 13 × 10).

Figs. 1–3.—Adult specimens of *Tethya* from the White Sea. On the surface are groups of buds on peduncles of different form, length, and size.

Fig. 4.—Probably a detached bud, throwing out in all directions long filaments and protuberances, which later will bear buds at their extremities.

Fig. 5.—Two specimens of the same *Tethya* attached to the interior surface of a *Terebratula*, without buds or any kind of protuberances on the surface.

Fig. 6.—On a long peduncle originating from the mother-body *x*, is a bud of irregular form *a*, on which are other buds, *b*, *c*, *d*.

Fig. 7.—Metamery in the disposition of the buds.

Fig. 8.—Dichotomous ramifications of the peduncle, having a bud at each extremity. That on the left side seems to be about to divide longitudinally, which will probably give rise to further dichotomy.

Figs. 9–11.—First stages of the development of buds. In addition to the long spicules, there are smaller ones in the form of stars.

Figs. 12, 13.—Buds at the surface of *Tethya lyncurium*, from Sicily.

---

* 'Arch. Zool. Exp. et Gén.,' viii. (1880) p. 417.


C. Mereschkowsky ad nat. del.　　　West, Newman & Co. lith.

External Gemmation in the Spongida

centimetre in diameter; the body is regularly globular in form, and is often found attached to the internal surface of some shell (*Terebratula*). It is of a clear yellow colour, sometimes darkened to brown; the regularity of the external form is seldom so well marked as in the large and small specimen figured in Fig. 5, and, as a rule (see Figs. 1–4), there are conical or filamentous projections from its surface. The strange appearance produced by these projections leads one at first to suppose that they are parasites; this view is shown to be incorrect by a closer examination. The most frequent arrangement is shown in Fig. 1, where we find ovoid or pyriform buds, rounded at one extremity and at the other passing into a more or less delicate stalk, of varying length. Sometimes (Fig. 1 *a*, 2 *a*) the buds are globular, and these are seen to be "covered with that layer of organic matters which is characteristic of an adult sponge"; these buds may even surpass in diameter the smaller specimen shown in Fig. 5. The foot or process which supports the bud is merely a delicate cylindrical filament, the length of which may be as great or greater than the diameter of the parent sponge (Fig. 3). In Fig. 8 we have an example of the dichotomous division of this filament. In some cases (see Fig. 7) we may find examples of buds of the second order, or (as in Fig. 6) a number of secondary buds (*b*, *c*) may arise from the primary one (*a*), and these may be in various stages. A tertiary bud (*d*) may also be seen arising from the stalk of a secondary bud (*c*).

The following is an account of the development of these structures; at certain points on the surface of the sponge there is an agglomeration of the syncytium into which there penetrates a number of long spicules; this aggregated sarcode forms a small cylindrical body, which gradually elongates; the spicules already formed are displaced by other fresh spicules; the outgrowing filament, after having attained a certain length, begins to form the bud at its tip (Figs. 9, 10, 11); the peduncle has no canal and no pores, so that the bud cannot be looked upon as being an invagination of the wall of the parent sponge, for the cavities which become developed in it arise independently, and have no connection with the cavity of the parent.

**General and Comparative Morphology of the Sponges.**—To the above paper is appended an abstract of M. Mereschkowsky's views on this subject, in which he compares the sponges with the Hydroida.

The formation of a very simple colony in the Hydroida is characterized by the fact that the new individuals are not fortuitously attached to the parent, but follow a rigorous law, so ordered that the appearance of one individual or tentacle is the signal for the appearance of an identical one opposite to it; after one pair has been developed others may follow, but they are always referable to the formula $2n$. Nothing like this is to be observed in most sponges; the buds do not seem to follow any law, and arise without any order. The second point of difference is that in the Hydroida the new individuals or tentacles form a ramified colony, in which every individual is completely distinct from its neighbours. Cases like this are as a rare exception (*Sycetta primitiva*) to be observed among sponges, but it is not the rule; in them the daughter-individuals have their walls fused together in such a way as to give rise to the appearance of a single organism. If, then, it is allowable to regard the tentacles of a Hydroid polyp as individuals distinct from the hydranth, we have to speak of it as a polymorphous colony, composed of individuals completely distinct and regularly arranged, while the sponge is formed by a colony of individuals irregularly arranged and fused into a single compact mass.

**New British Sponge.***—Mr. J. G. Waller describes and figures *Raphiodesma minima*, a new British sponge of small size ($\frac{1}{4}$ inch × $\frac{1}{8}$ inch), found by him at Torquay on a small pebble of limestone, held in the roots of *Laminaria saccharina*. It was unfortunately not in a fresh condition. The species is but little removed from *R. sordida*, and but for the absence of tricurvate and bihamate spicules, and the possession of long, hair-like, acerate spicules in the membrane, as it were in substitute, might easily be pronounced to be the same.

Mr. Waller also shows that *Hymeniacidon macilenta*, of Bowerbank, is in reality an early stage of *R. sordida*, of that author,† so that the former name should be abandoned.

## Protozoa.

**Infusoria as Parasites.‡**—Mr. W. S. Kent directs attention to the consideration of the innumerable forms of Infusoria which are referable to the category of "Parasites" in the strictest and simplest sense (as distinguished from "Commensals").

Amongst the Flagellata ten species are figured and described, parasites respectively of frogs and other Amphibia, the intestinal viscera of ducks and geese, the house-fly, the blood of Indian rats, a nematoid worm (*Trilobus gracilis*), the common cockroach, and the human nasal and respiratory passages, the latter being Dr. J. H. Salisbury's *Asthmatos ciliaris*, an active agent, as he considers, in the production of one form of the infection known as hay asthma or hay fever.

*Hexamita intestinalis*, which occurs abundantly in that prolific hunting-ground for parasitic organisms, the rectum and intestine of the frog, *Rana temporaria*, has recently (in association with examples of this Batrachian dissected at the South Kensington Biological Laboratory) been the object of investigation by the author, as the result of which some points of interest concerning the deportment of these singular organisms in the fluid medium they inhabit were placed on record. While usually described as essentially free-swimming organisms, it was found that they possess the faculty also of attaching themselves at will to associated objects, and of passing a temporarily sedentary existence. When first transferred to the field of the Microscope no such property is exhibited, the creatures hurrying hither and thither in the most aimless and excited manner. Gradually, however, their movements grow more

* 'Journ. Quek. Micr. Club,' vi. (1880) pp. 97–104, 1 plate.

† 'British Spongiadæ,' iii. p. 230.

‡ 'Pop. Sci. Rev.,' iv. (1880) pp. 293–309, 2 plates.

tranquil, till at length scarcely an animalcule is to be seen exhibiting its natatory capacities, all with rare exceptions having attached themselves to the organic debris or other suitable fulcra, through the medium of their two trailing posterior flagella, which possess a marked adhesive function. Sometimes the entire lengths of these filiform appendages are utilized as organs of adherence, and sometimes only their distal extremities.

Under these last-named conditions, a highly remarkable modification of the movements of the animalcule was observed. Where the adhesion is effected by the entire length of the flagella, the motion of the body is simply oscillatory, the four anterior flagella being deployed and agitated without apparently any definite plan of action. When, however, adherence is accomplished through the medium only of the terminations of the flagella, the body gyrates rapidly, and with rhythmical cadence, from right to left and left to right, such action causing the adherent flagella to become twisted on each other, while the four anterior ones describe elegant undulations round the animalcule's body. It would seem highly probable that the form described by Professor Leidy under the title of *Trichonympha agilis*, found within the intestine of the American white ant, *Termes flavicans* (likened by the discoverer to the performers in an American ballet, whose chief attire consisted of long cords suspended from their shoulders, whirled in mazy undulations around them as they danced), represented a species of *Hexamita*, observed under the conditions just described. Phenomena precisely identical with those just recorded of *Hexamita intestinalis* have been found by the author to obtain also in the non-parasitic and marsh-dwelling species, *H. inflata*.

Of the Ciliata fifteen species are figured and described, viz.: ectoparasites of young trout, the garden snail, *Hydra vulgaris*, a planarian worm, and the fresh-water sponge, endoparasites of man, frogs and toads, a myriapod (*Iulus marginatus*), the water-beetle (*Hydrophilus piceus*), the earth-worm, a marine planarian, and the intestinal and pulmonary cavities of fresh-water molluscs.

**Chlorophyll and Starch in Infusoria.*** — M. P. Van Tieghem mentions that he has often observed perfectly developed grains of chlorophyll in true Infusoria, and notably in *Stentor polymorphus*. Besides chlorophyll, the *Englenæ* contain grains of starch (*paramylon*).

**New Opalinids.†**—In 1879, M. E. Maupas described ‡ *Haptophrya gigantea*, a new Opalinid from the intestines of anourous Batrachia. M. A. Certes records having also found the Infusorian in *Bufo pantherinus* from Constantine. Despite the rapidity with which they died when removed from their natural surroundings, M. Certes succeeded in preserving some alive for five or six days in albuminous water, and made preparations in a mixture of osmic acid and 33 per cent. alcohol.

M. Certes confirms generally the description given by M. Maupas,

* 'Bull. Bot. Soc. France,' xxvii. (1880) p. 132.
† 'Bull. Soc. Zool. France,' iv. (1880) pp. 240-4, plate xii.
‡ See this Journal, ii. (1879) p. 588.

but finds the buccal sucker has a double crown (internal and external) of vibratile cilia stronger than those of the body. The internal crown is upon a kind of very fine membrane, and even the bottom of the sucker appears to be ciliated. Particles of carmine in the fluid in which the animal was swimming were drawn in by the current set up by these cilia and accumulated in the funnel of the sucker, without, however, penetrating into the interior of the body. According to M. Maupas, the long contractile canal communicates with the exterior by a certain number of very small oval orifices; but these M. Certes, though he sought very carefully for them, was unable to detect.

M. Maupas has placed the animal amongst the Opalinida, but M. Certes finds some difficulty in agreeing with this. The typical Opalinid (*O. ranarum*) is remarkable for the large number of its nuclei and the absence of a mouth. There is nothing similar in *H. gigantea*. The nucleus is single; the buccal sucker is, if not a true mouth, at least an organ *sui generis*, where the first acts of nutrition are localized. The thickness of the cuticle and the clear layer separating it from the mass of the body excludes all possibility of phenomena of endosmosis. On the other hand, M. Certes does not think it right to conclude that, because the solid particles of colouring matter drawn by the cilia into the funnel of the sucker do not penetrate the sarcode mass, the albuminous liquid, by which the animal is nourished, does not do so either, and that the sucker is only an organ of attachment. Moreover, the animal is more often found attached to the small *Tæniæ* of the intestine of *Bufo pantherinus* than even to the walls of the intestine. On these several grounds it should be considered to form a link between the true astomatous species (Opalinida) and those which have a well-defined buccal orifice.

In all probability, *Haptophrya gigantea* will not remain isolated in this new group. M. R. Blanchard found, in 1878, in the intestine of an Alpine Triton, an unknown Infusorian, which at first sight M. Certes thought was *H. gigantea*; but a closer scrutiny enabled him to recognize differences between the two species, though they were evidently closely allied.

In the preparations of M. Blanchard there is no trace of a dorsal canal, nor does he recollect having seen one in the living animal. In one of the individuals treated with osmic acid, there exists in the posterior portion of the body a large vacuole which may be the indication of the contractile vacuole. The cuticle has a double outline but is destitute of the characteristic striæ so conspicuous in the preparations of *H. gigantea*. Finally (the most important difference), the buccal sucker is replaced by an oval depression armed with very strong cilia, and which cannot be better compared, for form and general appearance, than to the mouth of a tiny whale, with its whalebone. The two extremities of this depression are connected by muscular cords (strongly coloured by the carmine), arranged so that the anterior part of the animal seems, under a low power, as though provided with a horse-shoe sucker abruptly terminated in the interior part. There are, besides, characters which establish apparently a clear line of demarcation, not only between the two species, but also between the Infusorian of the

Triton and *Balantidium elongatum* and *entozoon* that Stein has found in *Triton cristatus* and *tæniatus*.

*H. Tritonis* is proposed as the name of the new species.

Dr. E. Everts has recently published * the description of an Opalinid (*Opalina Discoglossi*) found by him at Naples, in *Discoglossus pictus*. In size rather than in general form, in habitat, in the existence of a single nucleus, a dorsal canal, and a sucker, and also in the great analogy in the phenomena of reproduction, this Opalinid singularly resembles that described by M. Maupas, with which, however, it cannot be confounded.

**Importance of Foraminifera for the Doctrine of Descent.**†—At the 53rd Congress of the Association of German Naturalists and Physicians held at Dantzig in September, Professor Möbius, of Kiel, read a paper with the above title.

He began by quoting Dr. Carpenter's view that the genera and species of the Foraminifera cannot be determined after the usual method, but that the only natural classification of the great mass of different forms is to arrange them in accordance with their degree of relationship. Professor Möbius himself had come to the conclusion from his researches among the Foraminifera which he had collected in Mauritius in 1874 that the repeatedly occurring peculiarities among the Foraminifera may serve and must serve in forming an idea of their nature and zoological position. The sarcode of the Foraminifera behaves with regard to the formation of the skeleton and shell just as does the protoplasm of the eggs of the Metazoa to the formation of the germs and of all organs proceeding from them. Like the protoplasm of the egg, it possesses a quite definite and hereditary capacity for self-development. As confirmatory of Darwin's theory of descent, they possess a value neither greater nor less than that of all other animal classes. The Professor's forthcoming work on the Foraminifera of Mauritius will contain much detailed evidence in support of his views.

In the discussion which followed, it was suggested that the point of difference between the author and Dr. Carpenter lay in the fact that Dr. Carpenter had regard to the sarcode rather than to the skeleton, to which latter Professor Möbius attached the greater importance.

**New Moneron.**‡—K. Mereschkowsky describes a new form (observed at Naples), under the name of *Monopodium Kowalevskyi*. It is, of course, non-nucleated, and has a fairly consistent granular protoplasm, with rounded vacuoles, varying but little in form. As a rule it only gives off a single homogeneous pseudopodium, which is about ten times as long as the diameter of the mass. Attaching itself to a filament of a *Leptothrix*, it gradually draws the body after it. When two individuals unite the component mass breaks up into three. This was the only mode of reproduction which was observed, and the observer has no information to give as to any other process for effecting the same result.

* 'Tijds. Nederl. dierk. Vereeniging,' iv. (1879) pp. 92–96, plate iv.
† 'Nature,' xxii. (1880) pp. 527–8.
‡ 'Zool. Anzeig.,' iii. (1880) p. 139.

# BOTANY.

## A. GENERAL, including Embryology and Histology of the Phanerogamia.

**Division of the Nucleus in the Pollen-Mother-cells of Tradescantia.***—According to Baranetzky, the mother-cells of the pollen of some species of *Tradescantia*, especially *T. virginica*, *pilosa*, *discolor*, *subaspera*, and *zebrina*, afford a remarkably good illustration of the mode of division of the cell-nucleus. Almost as soon as division commences they separate entirely from one another; and it is only necessary to crush the anthers in water under the cover-glass in order to get readily the cells swimming about separately in a state of division, and hence to observe the processes on all sides. Owing to the thinness of the protoplasm, the cells will remain uninjured for hours in river or spring-water without undergoing any material change; after a longer time the cell-contents contract without any formation of vacuoles. The nucleus can be readily made out, even when the cells lie only in water, from its density and sharp outline. The descriptions of the process by previous observers are in certain points incorrect, probably because it has been observed in salt or sugar solutions, in which the nucleus is not nearly so clear, instead of simply in water.

Very young pollen-mother-cells are filled with a moderately dense, finely granular protoplasm. The large nuclei, which are considerably denser, appear also to be finely granular; they have no membrane-like outermost layer. The behaviour of the nucleoli is not altogether clear. In *T. zebrina* there appears to be always a large nucleolus, while in the other species none was clearly visible, and in some it was altogether unrecognizable. Probably they are always present when the nucleus is in a state of rest. The division now proceeds in the way described by Hanstein. The dense parts of the nucleus, which at first appear like fine granules without definite form, increase in size, and gradually assume the form of short rods inclined in different directions, and separated by a sparse clear matrix. The appearance is, indeed, somewhat as if the nucleus were full of bacteria. A nucleolus can now be detected in the nucleus, usually with definite outline. The rods appear to be of different lengths, but their terminations are not readily made out; they become thicker, while their number decreases, and the nucleus becomes gradually denser and less transparent. At one stage the appearance is more that of uninterrupted threads than of rods or granules, and this is probably the case throughout.

As the process advances, the rods and threads, though increasing in size, never lose their sharp outline, while the quantity of the intermediate matrix diminishes considerably. The denser portions of the nucleus are in its periphery, and in immediate contact with the protoplasm of the cell; and this causes the nucleus to lose its smooth outline, and to bulge out with a number of protuberances, and it possesses this mamillated form when the rods have attained their full size.

The mass of the protoplasm of the cell is at first indistinctly finely

* 'Bot. Zeit.,' xxxviii. (1880) p. 241.

granular. When the differentiation of the nucleus begins, sharply defined round granules appear in it, the protoplasm becoming less transparent as they increase in number. These granules have much the appearance of starch-grains. They frequently collect at one side of the cell or form a ring round the nucleus; this ring or sphere afterwards becomes broader, the granules retreating towards the cell-wall, while the nucleus remains surrounded by a transparent and nearly homogeneous protoplasm.

In the final stage of the differentiation of the nucleus, the threads form a dense convolution, the substance of which is obviously finely granular. The line where they meet the periphery of the nucleus is very fine, and apparently not smooth, but granular; while in the centre of the convolution the outlines of the threads are not clearly discernible.

The next processes comprise the second stage of development, the phase of the division of the cell-nucleus. The outlines of the threads become sharper and their substance apparently denser and more homogeneous; and at the same time they begin to change their position, so as to lie more or less nearly parallel to one another, the convolution increasing at the same time in size, and assuming the form of a plate composed of serpentine threads. Some among the cells are distinguished from the rest by their size and transparency, although their nuclei have not more than the ordinary size. The threads now present the appearance as if they were elastic, and constantly endeavouring to free and straighten themselves; at all events the convolution breaks up eventually into small fragments. The nucleus is now practically composed of a great number of separate filiform fragments, without any special distinguishable intermediate matrix, the threads appearing to be surrounded by the same transparent cell-contents which fill up almost the entire cell-cavity.

The division of the convolution, and the development of the two new nuclei, usually proceed in the following way:—The plate, composed of transverse coils of threads, becomes thicker, often passing almost across the cell-cavity, and having sometimes somewhat of a stellate form. The threads at the same time break up into shorter rod-like fragments, their outline becoming also less sharp. The splitting of the disk now commences at right angles to the direction of the elements of the nucleus, beginning usually at the margin and advancing towards the centre. The two halves begin at once to separate from one another, but remain for a time connected in the middle. The intermediate space becomes filled with a very dense, opaque, and usually granular protoplasm, in which a delicate striation is sometimes to be seen. But the elements of the two halves of the nucleus possess undoubtedly from the first a certain polarity, that is, a tendency to separate in opposite directions, as may be seen from the position taken up by single free fragments. The two halves soon separate completely from one another, and when they have approached close to the cell-wall they are still composed of distinguishable rods or granules. The elements of the nucleus gradually fuse together, but its structure is still apparently not homogeneous.

When the new nuclei begin to round themselves off, the protoplasm again becomes more transparent; and the granules again collect into a peripheral zone, which includes the nuclei. The nuclear plate makes its appearance suddenly as a dark granular streak, occupying at first only the centre of the cell, and rapidly elongating on both sides until it reaches the periphery of the cell, and the division is complete. It is only after the complete division of the cell that the definite formation of the new nuclei commences, which gradually again attain their original uniform finely granular structure. During the development a considerable absorption of water must take place, the young nuclei becoming less dense and increasing at the same time greatly in volume.

The four pollen-cells which are formed from a single mother-cell are, in *Tradescantia*, always produced by two successive bipartitions, the processes being in all essential points the same in the second division as in the first.

The description now given applies to *Tradescantia virginica*, *subaspera*, and *pilosa*. In *T. discolor* the pollen-mother-cells are small, and filled with granular but slightly transparent protoplasm, and are therefore not so favourable for observation. Some peculiarities are presented by *T. zebrina*. The breaking-up of the nuclear threads into short, nearly oval fragments takes place at a very much earlier period. The nuclear plate has also more the character of a ring, its elements almost disappearing from the centre and collecting near the periphery.

The nuclear threads so often referred to can be crushed out and their structure examined in water. They are then seen to be longer or shorter, often vermiform threads, the ends of which are always smoothly rounded off. Their substance is not homogeneous, but consists of a less dense matrix, and a denser portion which assumes the form of an elevated ridge running spirally round the length of the thread, and which can be even separated from its mass.

Baranetzky observed also the course of the division of the pollen-mother-cells in other plants, both monocotyledons and dicotyledons, especially in *Agapanthus umbellatus*, *Hemerocallis flava*, *Yucca gloriosa*, *Hesperis matronalis*, *Lathyrus odoratus*, and *Pisum sativum*. None of these present any differences, except in subordinate points. In *Pisum* the process is extremely similar to that in *Tradescantia zebrina*, the breaking-up of the nuclear threads taking place at an early period. In *Hesperis* the substance of the nucleus is from the first differentiated into rod-shaped, and in *Pisum*, *Hemerocallis*, and *Yucca* into perfectly isodiametrical elements. The filiform nature of the dense elements of the nucleus is therefore not a universal rule.

In conclusion, the following may be stated as the three most important points in the division of the mother-cells of pollen :—

1. The differentiation of the mass of the nucleus; that is, the gradual separation of the dense substance, which then assumes the form, according to the species of plant, of long vermiform threads, shortish rods, or roundish bodies, which may be called the elements of the nucleus.

2. The tendency of the nuclear elements to separate from one another in the equatorial plane of the cell, or rather, to approach the

cell-wall in this plane and arrange themselves into the nuclear plate which, in *Tradescantia zebrina*, has the form of a ring, and in other species of *Tradescantia* of an absolute flattening of the differentiated nucleus.

3. The point where the centres of attraction appear to be shifted. The nuclear elements are now drawn to the opposite poles of the cell, their separation being thus determined into two distinct groups or new nuclei.

**Multinucleated Cells in the Suspensor of Dicotyledons.***—In pursuance of recent discoveries by the author himself, Strasburger, Treub, Schmitz, and others,† of the existence of a plurality of nuclei in vegetable cells, Hegelmaier has closely examined and described a similar phenomenon in the suspensor (pro-embryo) of certain dicotyledons belonging to the tribe Vicieæ of Leguminosæ. The species specially examined were *Pisum sativum*, *Lathyrus sylvestris*, *odoratus*, *Ochrus*, *pratensis*, *stans*, *Aphaca*, and *Nissolia*, *Orobus vernus*, *niger*, *tuberosus*, and *albus*, *Lens esculenta*, *Vicia sepium*, *pisiformis*, and *tenuifolia*, and *Cicer arietinum*. Of these the last is the only one that presents any important differences from the rest.

The peculiarity presented by all the species above mentioned, and probably by all belonging to the tribe, is that the fully developed suspensor, which is of considerable length, is always composed of the same number of cells, viz. four; exceptions to this being rare abnormalities. The structure consists of two parts, each composed of a pair of cells. At full maturity the cells of the apical pair are swollen out, and closely adpressed to one another with flat surfaces, so as to form a roundish ellipsoidal or nearly spherical ball. They contain a somewhat coarse-grained protoplasm forming a parietal layer of variable thickness, imbedded in which are large nuclei placed at uniform distances, the number of these nuclei appearing to depend on the size of the ball, which varies with the species. The average number is perhaps from twenty to thirty, at least in species with large flowers and seeds; in *Lens esculenta* there were found only from twelve to sixteen, in *Vicia tenuifolia* about eight, and in *Lathyrus stans* and *Nissolia* only four. When, as in *Lathyrus sylvestris*, these cells are smaller, the number of nuclei is still considerable.

The two basal cells of the suspensor form, as it were, a kind of pedicel to the capitulum; its cells are much narrower, and taper off gradually to the base. The number of nuclei in these cells is still larger, and depends on their size. In the upper, broader part of the pedicel they are imbedded, at uniform distances, in the parietal protoplasm; in the lower, narrower part they are arranged in several rows; in the narrowest basal portion the protoplasm is no longer in the form of a parietal layer, but is a mucilaginous mass occupying nearly the whole of the cell-cavity.

The form of the nuclei presents nothing remarkable; in each, when mature, is a large, strongly refractive, and sharply defined nucleolus. In old nuclei two nucleoli are occasionally found.

* 'Bot. Zeit.,' xxxviii. (1880) p. 513.

† See this Journal, ii. (1879) p. 606, and *ante*, pp. 111, 303, 482, 493.

All four cells of the suspensor display a tendency to round off, and for the dividing cell walls to split into two lamellæ, so that they very readily separate from one another, as also does the embryo from the suspensor, being sometimes attached to it only by a common external layer of mucilaginous protoplasm.

The cell walls of the suspensor are extremely delicate, and it is even doubtful whether they are composed of cellulose or any isomerical substance. The entire absence of cuticularization suggests the explanation offered by Treub,* that the suspensory cells themselves absorb nutriment for the embryo, partly from the integuments and funiculus, partly from the tissue of the placenta. The ovules of the Vicieæ are, like those of other Leguminosæ, campylotropous, and the chalazal portion is separated from the much narrower micropylar end by an elevated ridge. The long suspensor raises the embryo into the micropyle, or even beyond it, which is a great advantage.

In all the Vicieæ, at the time when the formation of the embryo commences, the ovule and embryo-sac are but slightly curved; there is as yet no nucellar tissue; the inner integument is present, but is much thinner than the outer one. The longitudinal division which separates the two cells of the lower part of the suspensor from one another is formed much earlier than that which divides the two apical cells from one another. Sometimes, even before the latter is formed, the nuclei in the two lower cells begin to divide. The two nuclei thus formed lie in such a position towards one another as if a transverse septum had been formed between them; but there is never the least trace of such a septum. This division of the nuclei then advances from the base towards the apex. Not until the nuclei in the lower cells have reached a certain number, at least sixteen, do those in the upper cells begin to divide; the formation of division-walls is in them also extremely rare.

The division of the nucleus is always preceded by that of its large nucleolus, which elongates, and becomes constricted into a dumb-bell-like form; the entire nucleus then assuming a long ellipsoidal or fusiform shape; but only after the nucleolus has completely divided does the constriction of the nucleus itself begin. While the definition of the nucleolus is always sharp, the nucleus appears, during the process of division, to coalesce, at its periphery, with the surrounding protoplasm.

*Cicer* presents several peculiarities in the form and development of the suspensor. Instead of consisting of four multinucleated, it is composed of a larger number of uninucleated cells, viz. from six to nine, on the average about seven pair. Each contains a large nucleus imbedded in the parietal protoplasm, and subsequently a refractive spherical nucleolus. The cell-walls, though still thin, are considerably firmer than in the other Vicieæ. The number of cells, and consequently of nuclei, in the suspensor of *Cicer* is not so large as that of the nuclei in other genera, and may even be not so large as that of the nuclei in a single multinucleated cell. The second peculiarity of the embryo of *Cicer*—whether connected or not with

* 'Notes sur l'embryogénie de quelques Orchidées.' 1879.

the first is uncertain—is that the entire large-celled suspensor, with the exception of its narrow basal end, as well as the embryo, is surrounded by an endosperm which develops in the micropylar half of the young seed; the base of the suspensor itself entirely fills up the narrow pointed apical end of the embryo-sac.

**Latex and Laticiferous Vessels.***—M. E. Faivre gives the following as the main results of a very careful study of latex and laticifers in the embryo and seedling of *Tragopogon porrifolius*.

The laticiferous vessels are first formed at the same time as the other vessels, in the cotyledons, the plumule, and the radicle. They are produced, like the rest of the vessels, by the union of cells, not as simple intercellular spaces, and then undergo further development by the elongation of protuberances which are already present in their wall; they are simply or reticularly branched; their ends are blind. The laticiferous vessels most closely resemble tracheïdes in their general distribution, and occur in all parts of the young plant; they are much more numerous in the cotyledons which contain chlorophyll than in the plumule, and still more so than in the radicle. In the interior of the cotyledons they appear at once in ribbon-shaped and reticulated groups.

As regards the latex itself, the author distinguishes between an original latex (*latex primordial*), which is formed before the chlorophyll, and the latex properly so called, which arises at a later period.

The author believes the latex to be a reserve-material, the essential composition of which is undoubtedly related to that of protoplasm. It consists fundamentally of fats and nitrogenous substances, and is hence of great service to the plant. It appears in the plant in its earliest stages of development, and is deposited, like other reserve-materials, independently of the action of light and of the presence of chlorophyll. When the plants are etiolated by the removal of light, they lose their latex, just as, under similar circumstances, the starch stored up as reserve-material also disappears. The yellow rays of light favour the production of latex, just as they do the formation of starch or oil in the chlorophyll-grains. When air is excluded under a high temperature, the phenomena of etiolation are exhibited in the diminution both of the latex and of the protoplasmic reserve-materials. With access of air and a lower temperature, the amount of protoplasm increases, as also, under similar conditions, does the reserve-starch. Different soils cause an increase or diminution of the latex, according as they promote or retard the development of the plant.

**Rudimentary Coma in Godetia.**†—While investigating the development of the embryo-sac in the different genera of Onagraceæ, Mr. J. M. Coulter's attention was attracted to certain hair-like projections which appeared upon the forming ovule of *Godetia* (probably *G. grandiflora*). A careful examination showed them to be identical in structure with the forming hairs in the coma of *Epilobium*. They occurred almost exclusively at the chalazal end, one or two scattered

* 'Mém. Acad. Sci. Lyon,' xxiii. (1878–79) p. 361. See 'Bot. Centralbl.,' i. (1880) p. 747.

† 'Bot. Gazette' (Indiana), v. (1880) p. 75. See 'Nature,' xxii. (1880) p. 595.

ones being detected farther down upon the raphe. A study of the development of the coma of *Epilobium* shows that the first indication of it is a tuberculated appearance of the chalazal end. Presently these tubercles push out into elongating nucleated cells, which eventually develop into the long hairs of the coma. Now *Godetia* permanently retains this tuberculated margin at the upper end, but does not usually develop its coma any further. In the cases examined, however, the forming ovules (either in reminiscence or prophecy) stretched out their tubercles into incipient hairs. Tracing these ovules in their subsequent development, it was found that these hairs gradually disappeared until, when the ovules had become anatropous, there was no indication of them.

As *Godetia* has been merged into *Œnothera*, many species of the latter were examined to see if any such thing occurred in them; but no trace of such growth was detected. This would seem to indicate that if *Godetia* be not entitled to generic rank, it is at least that part of *Œnothera* which approaches *Epilobium*. A discrepancy must, however, be noticed here. In *Epilobium* the hairs of the coma do not begin to form until the ovule has become completely anatropous; but in the *Godetia* observed the incipient coma had all disappeared by the time the ovule had become anatropous, beginning to form before the nucleus is half covered by the coats. These hairs appeared in greatest size and abundance when the axis of the ovule was at right angles to its anatropous position.

**Nectariferous Trichomes of Melampyrum.***—On the under side of the bracts of *Melampyrum nemorosum* and *arvense* are minute scales, in the former case colourless, in the latter a dark violet, which E. Ráthay has determined to be nectariferous glands, freely visited by ants; and similar organs occur also in other species of *Melampyrum*. The secretion contains at least 2 per cent. of sugar, which does not reduce copper-oxide in the cold. This secretion is rapidly replaced if removed from the scales. In addition to ants, the secretion is eagerly devoured by other hymenopterous insects, especially humble-bees. The gland itself consists, in the species *M. arvense*, *nemorosum*, *pratense*, and *barbatum*, of a short pedicel-cell and a circular peltate disk, composed of a single layer of prismatic cells. They belong to the structures called by de Bary epidermal glands; since they excrete a fluid on the upper side of the disk between the cuticle and the cell-wall of the prismatic cells, which is freed by the rupture of the cuticle.

With regard to physiological function, the author is unable to agree either with the explanation of Kerner of the purpose of extra-floral nectaries, that they attract insects which would otherwise attack the flowers and other essential organs, or with that of Delpino and Belt, that they attract insects which are hostile to and destroy those that are injurious to the plant, but does not offer any explanation of his own.

**Threads of Protoplasm on Glandular Hairs of Silphium.**†—According to Dr. F. Ludwig, these hairs on the inner side of the leaf of *Silphium perfoliatum* have been found to bear oscillating

* 'SB. k. Akad. Wiss. Wien.' lxxxi. (1880) p. 55.

† 'Kosmos,' vii. (1880) p. 47.

threads of protoplasm, which may be extended to a greater or less distance, or may be retracted, and resemble in all points those of *Dipsacus*. The leaves of *Silphium* are also united into a kind of cup as in *Dipsacus*, and probably serve both as a reservoir of water to protect them against the attacks of insects and mollusca, and as a trap to catch insects for the sake of the nutriment derived from their bodies. It is suggested that the occurrence of these threads in connection with the leaf-cups in the two genera probably shows a certain relationship between the two parts, and the former one probably utilized for the absorption of nitrogenous substances from the water, as supposed by Darwin to be the case. The glands of *Silphium* differ from those of *Dipsacus* in their multicellular stalk, unicellular elliptical head, smaller size, and greater numbers.

**Resin-passages in the Coniferæ.*** — As a sequel to previous investigations of the subject,† T. F. Hanausek has now examined the resin-passages in the cone-scales of *Pinus Laricio*, *Abies pectinata*, and *A. Larix*, with the following results.

The epithelium of the resin-passages is neither lignified nor suberized, but consists of cellulose only, with the exception of that of *Biota* and *Abies pectinata*, which undergoes a transformation resembling suberization. In the cone-scales of conifers there are both schizogenous and lysigenous resin-receptacles, the former in the bast-fibre-zone, the latter abundantly in the fundamental tissue. The position of the resin-passages appears often to depend on the position and development of the vascular bundles, and to be associated with their formation.

The author distinguishes four kinds of resin-formation:—(1) The resin may be formed as a true secretion in true secretive organs. (2) It may arise from a deliquescence of the outer walls of particular cells (*schizogenous* resin-passages). (3) From metamorphosis of the entire cell-wall and cell-contents (*lysigenous* and pathological resin-passages). (4) By the transformation of certain contents; this frequently occasioning an increase of the resin formed in the 2nd and 3rd modes.

In the cones of *Pinus* and *Biota*, which remain green for so long a time, the resin, which frequently escapes and flows over the outside of the scales, must serve as a protection against the attacks of birds; when the scales become woody and nearly free from resin, the seeds are already ripe, and no protection is necessary.

**Influence of Light on the Transpiration of Plants.‡**—The results of the experimental researches of M. H. Comes agree entirely with the facts already obtained on physical principles, and he sums them up in the following propositions §:—

1. The emission of aqueous vapour which takes place in plants is subject not only to the action of the physical agents which influence

* 'JB. N. Oestr. Landes-oberreal- u. Handelsch. in Krems,' xvii. (1880). See 'Bot. Centralbl.,' i. (1880) p. 776.

† See this Journal, *ante*, p. 113.

‡ 'Comptes Rendus,' xci. (1880) p. 335.

§ The details of the experiments, the numerical data, plates, &c., will be published in 'Atti R. Accad. Lincei' (Mem.), vii. (1880).

ordinary evaporation from a free surface of water, but also to the influence of light. Consequently, under similar conditions, a plant transpires more under the action of light than in darkness.

2. The action exerted by light on the transpiration of plants augments in proportion to its intensity; consequently under similar conditions transpiration reaches its maximum shortly after noon.

3. Light favours transpiration only by that part which is absorbed by the colouring substance of the organ; therefore, under similar conditions, the organ which is coloured with the greatest intensity transpires more, and the transpiration is most active in the part of the spectrum where the light is most absorbed.

4. The luminous rays which are absorbed by the colouring substance of an organ alone favour the transpiration of the organ; therefore, under similar conditions, the transpiration of a coloured organ will attain its minimum under the influence of light of the same colour as the organ, and its maximum under the influence of the complementary colour.

**Heliotropism.***—In a preliminary account of a recent series of observations on heliotropic phenomena, J. Wiesner gives the following as some of the more important points arrived at.

In very strong light, even rays which have no heliotropic properties, possess under certain circumstances the property of strongly retarding growth. The prevalent theory that only rays belonging to the more refrangible half of the spectrum have the power of inducing heliotropism and hindrance to growth must be modified, since the ultra-red, red, orange, and even yellow rays, possess this property under certain conditions. The liability to heliotropism is always the result of the relatively greater extensibility of the cell-wall on the shaded side of the organ; but the curvature itself is only completed by turgidity. Positive heliotropism and negative geotropism act in opposition to one another in erect organs; in vertical organs which grow downwards the heliotropic and geotropic effects co-operate. Whenever heliotropism depends on definite mechanical processes which take place in the cells, it must be regarded as a phenomenon of adaptation, and may commence even in organs which have not themselves any reference to light in their functions. The author believes the physiological purpose of heliotropism to be to place in the most favourable intensity of light those flowers which are dependent on insect-fertilization. In those plants where heliotropism would be injurious, no tendency is found towards heliotropic curvature.

**Formation of Chlorophyll in the Dark.**†—M. d'Arbaumont has followed out the investigations of M. Flahault ‡ respecting the apparent exceptional formation of chlorophyll without access of light. The case to which he has paid especial attention is that of the appearance of chlorophyll-grains in the internal tissue of the ripe fruit of the

* 'SB. k. Akad. Wiss. Wien,' lxxxi. (1880) p. 7.

† 'Bull. Soc. Bot. France,' xxvii. (1880) p. 89.

‡ See this Journal, *ante*, p. 298.

pumpkin (*Cucurbita maxima*). They were invariably found in the large cells with thin walls near the carpellary furrows, or near the seeds in the variety known as "Potiron jaune gros."

M. d'Arbaumont is of opinion that neither of M. Flahault's hypotheses—that the grains are formed in a young and semi-transparent condition of the tissue or at the moment of exposure—will apply in the present case; but that they are actually formed in the dark. In support of this view he cites the fact that he has observed in this situation grains of chlorophyll in an active and not in a dormant state, viz. actually in various stages of division, or evidently only just formed in cells which have quite recently divided. He further observed that the cells containing chlorophyll were always situated either in contact with or in close proximity to reservoirs of nutrient substances, and especially to deposits of starch. The grains of chlorophyll are dissolved in two ways, centrifugally or centripetally, i. e. either advancing from the centre towards the periphery, or the reverse.

**Chlorophyll in the Leaves of the Canada Vine.***—According to Schnetzler, the red leaves of the Canada vine (*Ampelopsis hederacea*) still contain chlorophyll, which is, however, concealed by a red substance soluble in alcohol. Chlorophyllin can be separated from it by means of ether, but is present in very small quantities in proportion to the red pigment. This latter is probably a derivative of chlorophyll, but not identical with it. If potassa is added to the red alcoholic solution, it becomes of a beautiful green colour, but is not fluorescent, by which it is distinguishable from true chlorophyll.

**Absorption of Water by the Leaves of Bulbous Plants.**†—From experiments on this subject made on a hyacinth deprived of its dry tunicated coats, the leaves of which, but not the bulb, were plunged in water, M. Mer deduces the following conclusions:—

The leaves of bulbous plants absorb the water in which they are immersed, so as to bring them to the condition maintained by the bulb in free air. The absorption goes on without there being any need first to diminish their turgidity, simply in consequence of the flow of water caused by the transpiration of the bulb. The current from below upwards (the plant being reversed) is not so strong as it would be in the opposite direction when the leaves are slightly withered. The renewal of turgidity is therefore due in part to the water derived from the bulb; it is only from this source that the leaves draw it when the experiment is made under a bell-glass, and when the bulb is still fresh. They do not absorb the external moisture when otherwise sufficiently supplied with water.

**Disengagement of Carbonic Acid from the Roots of Plants.**‡—In pursuance of his former investigation of this subject, as previously

* 'Bull. Soc. Vaud. Sci. Nat.,' xvi. (1880) p. 701. See 'Bot. Centralbl.,' i. (1880) p. 655.

† 'Bull. Soc. Bot. France,' xxvi. (1879) xli.–iv.

‡ Ibid., xxvii. (1880) p. 113.

reported,* M. Cauvet now adds the following as definite conclusions:—

1. The roots of plants are constantly disengaging carbonic acid.

2. This exhalation is less active by night than by day.

3. The disengagement increases at sunrise, diminishes towards the middle of the day, and increases again in the evening.

4. The exhalation is, in proportion, more considerable during any one diurnal period than during the night.

5. The activity of the roots is hence less by night than by day, at least as respects their respiration.

6. If the root absorbs carbonic acid from the soil, it is possibly only that which has served for the dissolution of the insoluble salts, carbonates, phosphates, &c., necessary to the life of the plant.

**Digestive Principles of Plants.**†—Dr. Lawson Tait has recently investigated afresh the digestive principles of plants. While he has obtained complete proof of a digestive process in *Cephalotus*, *Nepenthes*, *Dionæa*, and the Droseraceæ, he entirely failed with *Sarracenia* and *Darlingtonia*. The fluid separated from *Drosera binata* he found to contain two substances, to which he gives the names "droserin" and "azerin."

Dr. Tait confirms Sir J. D. Hooker's statement that the fluid removed from the living pitcher of *Nepenthes* into a glass vessel does not digest. A series of experiments led him to the conclusion that the acid must resemble lactic acid, at least in its properties. The glands in the pitchers of *Nepenthes* he states to be quite analogous to the peptic follicles of the human stomach; and when the process of digestion is conducted with albumen, the products are exactly the same as when pepsine is employed. The results give the same reactions with reagents, especially the characteristic violet with oxide of copper and potash, and there can be no doubt that they are peptones.

**Nutrition of the Drosera.**‡—Contrary to the views of Reess and Darwin, E. Regel finds that the plants thrive best when not treated with animal food, and is of opinion that their sustenance is properly derived through the roots.

**Botanical Micro-Chemistry.**§—In a Danish work on this subject, V. A. Poulsen gives a résumé of the most important micro-chemical reagents, and the modes of investigation employed in micro-chemistry.

The first section treats of the reagents. In each case the composition is given, and the cases in which each reagent should be employed, and its characteristic reactions. The second section treats of vegetable substances, and the methods of proving their presence by the aid of micro-chemistry. Among the substances thus discussed are cellulose,

* See this Journal, *ante*, p. 665.

† 'Proc. Birming. Phil. Soc.,' i. (1880) pp. 125–39. See 'Nature,' xxii. (1880) p. 521.

‡ 'Journ. Chem. Soc.,' Abstr. xxxviii. (1880) p. 820; from 'Bied. Centr.,' 1880, p. 482.

§ Poulsen, V. A., 'Botanisk Mikrokemie,' Copenhagen, 1880 (Danish). See 'Bot. Zeit.,' xxxviii. (1880) p. 526.

lignin, suber, protein compounds, protoplasm, starch, sugar, oil, resin, &c.; the vegetable salts, colouring substances, &c.

**Red Pigment of the Flowers of the Peony.***—J. B. Schnetzler has examined the red colouring-matter of the peony, and finds that the red alcoholic solution assumes, on evaporation in the air, a beautiful amaranth-red colour. The dry residue is of the same colour, even under the influence of direct sunlight. Calcium oxalate changes the purple-red colour of the alcoholic solution into a pure fiery red. If a very dilute solution of calcium carbonate is carefully poured, in small quantities, on to the red alcoholic solution, the colour changes successively into purple, purple-violet, blue, green, and yellow. The green colour has a red tinge in transmitted sunlight. When exposed to light, the green colour passes into yellow; and this yellow colour is not changed by acid or alkaline reagents; while the green colour is changed back by acid reagents into red.

The reagents employed in these experiments are substances which occur abundantly in the living plant, or, like calcium carbonate, are taken up by it. If a solution of ferro-ferrid-oxide sulphate is added to the dilute red alcoholic solution, a blackish-blue precipitate is produced, showing the presence of a substance belonging to the tannin-group. This occurs also as an accompaniment of the red pigment of the rose and *Ribes sanguineum*, and appears to have some genetic connection with these colouring-matters.

More than a hundred red, violet, and blue flowers gave similar results when treated with the same reagents. In all there is a chromogen which is soluble in alcohol, and is coloured red by acid, purple-red, violet, blue, green, or yellow by alkaline reagents.

**The Cell as an Element.**—See M. P. Van Tieghem's paper on 'Social Bacteria,' *infra*, Fungi.

## B. CRYPTOGAMIA.

### Cryptogamia Vascularia.

**Development of the Sporangium in Vascular Cryptogams.**†—K. Goebel has closely investigated the comparative history of development of the sporangium in vascular cryptogams, with a view of showing the close analogy displayed to that of the pollen-sacs and ovules (microsporangia and macrosporangia) of flowering plants. Previous observers have, for the most part, stated that the spores of vascular cryptogams result from a sporogenous tissue formed by irregular cell-division within the sporangium. The present writer asserts, on the other hand, that in vascular cryptogams, as in phanerogams, the spore-forming tissue can always be traced back to a single cell, or a row or layer of cells, which can, at a very early period, be distinguished, by the nature of its contents, from the remaining cellular tissue; and that the sporogenous tissue results from the perfectly regular division of this primary cell, row, or layer of cells, to which Goebel applies the term *archespore*.

* 'Bot. Centralbl.,' i. (1880) p. 682.

† 'Bot. Zeit.,' xxxviii. (1880) pp. 545–52, 561–71.

In the typical Filicineæ, the course of development of the sporangium is well known. A single epidermal cell of the leaf swells out, forming the mother-cell of the sporangium, within which a pedicel-cell is first of all separated by a septum from the mother-cell of the capsule. This last then divides into four parietal and one central cell, the latter being the archespore, distinguished by the large amount of protoplasm that it contains, from which the spore-forming tissue is developed. The archespore then forms two layers of so-called "mantle-cells," surrounding the central cell, and corresponding to the "tapeten-cells" in the pollen-sac of phanerogams. The archespore is, therefore, in the typical Filicineæ, a hypodermal cell.

In the Ophioglossaceæ, the process is somewhat different, the sporangium originating not from a single cell, but from a mass of cells. The young sporangia of *Botrychium Lunaria* are masses of cells forming a hemispherical protuberance. Notwithstanding the contrary statement of Russow, the archespore from which the sporogenous tissue is developed is here also, as in typical ferns, a single cell, although occupying a different position. The archespore is here the terminal cell of the axial row which lies beneath the still unilamellar epidermis, and is distinguished from the adjacent cells by its abundant protoplasm, soon also surpassing them in size. The mantle-cells are formed by divisions in the epidermal cell which lies immediately above the archespore. The archespore at the same time divides into four daughter-cells.

The development of the sporangia of the Equisetaceæ closely resembles that of *Botrychium*. The archespore is here also the terminal cell of a hypodermal row, formed on the under side of the sporangiophore, and is originally unicellular; the sporogenous tissue resulting from its division. In specially vigorous sporangia it is possible that it may occasionally be bicellular, and it at all events divides longitudinally at a very early period into two cells. The mantle-cells are formed in the same way as in *Botrychium*, but are not so sharply defined.

Closely resembling the processes above described is that in *Lycopodium* (*Selago*). The sporangium arises at the base of the leaf, and attains its subsequent axillary position by displacement; it originates from a few cells. The centre one of these grows the most vigorously, and subsequently gives rise to the archespore. As in *Botrychium* and *Equisetum*, the archespore, distinguished by its size, abundant protoplasm, and the power of swelling of its cell-wall, is the terminal cell of an axial row lying beneath the wall of the young sporangium. In *L. annotinum* and other species the processes appear to be the same.

In *Isoëtes*, the origin of the sporangium is a group of cells at the base of the leaf. In its earliest stage the archespore, both of the macrosporangium and the microsporangium, is here not a single cell, but is composed of a layer of cells. A difference then sets in between the development of the microsporangia and macrosporangia. In the former the archespore-cells elongate in a direction vertical to the surface, and divide by septa. No difference is yet discernible between the sterile and fertile cells; but subsequently some rows of cells are arrested in their growth, lose their abundant protoplasm, and divide only into elongated tubular cells. These are the sterile cells or trabeculæ. The sporogenous cells, continuing to grow and retaining their protoplasm, divide only by transverse septa. In the macrosporangium the fertile cells of the archespore undergo no further divisions than those which result in the formation of the mantle-cells.

A close analogy may be drawn between the development of the macrospore of *Isoëtes* and that of the embryo-sac of phanerogams, the chief difference being that the mother-cells are, in the former case, numerous, while in the latter case there is usually only one. In the Coniferæ the mother-cells of the embryo-sac (archespore) originate from the hypodermal layer, and their depression in the interior of the macrosporangium corresponds to that in *Isoëtes*. In both cases the embryo-sac consumes the surrounding tissue. Occasionally, in gymnosperms, there is more than one embryo-sac mother-cell; but they are not then, as in *Isoëtes*, separated by a sterile tissue (the trabeculæ). In angiosperms and in *Ephedra*, the archespore has been shown, by Warming and Strasburger respectively, to consist of a layer of cells, as in *Isoëtes*. A similar comparison may be drawn between the development of the microsporangium of *Isoëtes* and that of the pollen-sac of phanerogams.

In the Bryineæ and Sphagnaceæ the archespore consists of a layer of cells; and this is also the case in certain Hepaticæ, certainly in the Anthoceroteæ; while, in *Riccia*, there is no separation into a sterile part of the capsule and an archespore.

### Muscineæ.

**Structure of the Stem of Mosses.***—M. l'Abbé Hy has carefully studied the structure of the stem of mosses belonging to the family Polytrichaceæ, especially of the species *Atrichum undulatum* and *Polytrichum commune*. The following is a summary of the most important results:—

1. The anatomical structure of the stem in this family is more complex than has hitherto been supposed, and includes six well-marked different kinds of tissue. One of these, termed by Schimper the woody tissue, is itself made up of three characteristic regions.

2. The stem is not uniform, nor reducible to a single type. In one species, for example, *Polytrichum commune*, very important differences of structure may be observed at different heights, which may be arranged under three kinds, connected by intermediate forms. Even the external configuration varies, from cylindrical to triangular prismatic, and irregularly polygonal towards the summit. The diameter increases progressively, from $\frac{1}{3}$ mm. to $1\frac{1}{4}$ mm., that is, about in the proportion of 1–4.

3. A cortical investment, similar in appearance to that which has long been known in the case of the Sphagnaceæ, and of which some traces are also found in the genus *Philonotis*, exists also well developed at the base of the stem of our indigenous *Polytrichums*, and even of

* 'Bull. Soc. Bot. France,' xxvii. (1880) p. 106.

*Atrichum undulatum*; it generally consists of three or four layers of cells.

4. This cortical tissue has nothing in common with that of *Sphagnum* except its appearance and its physiological function; regarded from the point of development, it is entirely different. It is interior with respect to the epidermal layers, instead of exterior, as in the Sphagnaceæ.

5. The true epidermis, characterized by the presence of hairs, exists with certainty only in the lowest and subterranean portion of the axis. The absolutely glabrous aerial stem is probably destitute of an epidermis properly so-called; the zone distinguished under this name by authors belongs in its origin to the fundamental tissue, from which it differs in its narrow coloured cells. If the true epidermis is continued upwards as far as the stolons, it is only on the dorsal side of the scaly appendages, following two projecting lines bordering the median nerve.

6. The multiplicity of bundles noticed by Sachs in *Polytrichum commune* is to be observed only at the summit of the stems, and is not peculiar to this species. These isolated bundles in the midst of the fundamental parenchyma are not, as Sachs states, similar to the axial bundle; in addition to their never containing any medulla, they are, in the Polytrichaceæ, more simple than this axial bundle; while, on the contrary, in *Atrichum undulatum*, they are remarkable for the complication of their structure.

7. A ternary symmetry prevails in the general disposition of the tissues, but this is strikingly regular only in the subterranean region; in proportion to the height on the axis it becomes more obscure, and finally completely disappears.

**Stomata of Marchantiaceæ.***—The stomata of Marchantiaceæ are, according to Leitgeb, of two kinds, simple and canaliculate. The former, which occur in *Sauteria*, *Grimaldia*, *Reboulia*, *Fegatella*, and *Targionia*, are epidermal pores, situated immediately above the air-cavities. The latter kind, found in *Marchantia* and *Preissia*, appear like canals excavated in the surface of the thallus, and opening into the air-cavities; they occur also in the fructification of all Marchantiaceæ.

The mode of formation of the canaliculate stomata resembles that of the intercellular spaces in the Riccieæ. On the cells which constitute the epidermal layer at the point of the surface which lies immediately behind the apex, pit-like depressions are formed at the angles of the cells, which subsequently assume the appearance of canals penetrating the superficial layer of cells. From this layer proceeds the whole of the dorsal tissue of the thallus, which is penetrated by air-cavities, including the epidermis, and the mode of growth of this portion of the thallus determines whether the canals retain their original form or increase to large air-chambers, which then either remain open through their entire breadth or are covered by a growth which advances *pari passu* with their development. The pits are properly to be regarded as depressions of the surface,

* 'SB. k. Akad. Wiss. Wien,' lxxxi. (1880) p. 40.

formed by particular portions of the epidermis becoming covered by the more rapid growth of the adjoining parts. The process is, in fact, the same as in the formation of the sexual organs. The author is of opinion that the pores and canals are primary, the air-chambers secondary formations, notwithstanding the occurrence of apparent deviations, as in *Marchantia*.

With respect to the filling up of the air-chambers, they may remain altogether empty, as in *Sauteria* and *Oxymitra*. But more frequently segmented rows of cells proceed both from the basal inner wall and from the lateral walls, running towards the covering of the air-chamber; this occurs in *Marchantia*, *Preissia*, *Lunularia*, and *Fegatella*. Finally, as in *Reboulia*, rows of cells grow out into the air-chamber from all the inner walls of the cells which bound it, including the covering while in process of formation, thus dividing it into a number of imperfect chambers.

**Inflorescence of the Marchantiaceæ.***—The inflorescence of the Marchantiaceæ takes the form of disks sessile upon the thallus or of umbels elevated above it on a pedicel. The best-known examples are the male and female inflorescences of the genera *Marchantia* and *Preissia*. It has long been held that these receptacles and their pedicels must be regarded as metamorphosed foliar axes; as is shown by (1) the remarkable coincidence in structure of the dorsal side of both male and female receptacles with that of the corresponding side of the sterile part of the thallus; (2) the altogether similar dorsi-ventral development of the pedicels to that of the thallus; (3) the aerial layer and stomata which continue without interruption from the thallus to the pedicels; and (4) the ventral or radical channels of the pedicel with their scales, which must certainly be regarded as the equivalent of the ventral side of a portion of the thallus.

In an exhaustive treatise on the subject, Leitgeb maintains that the attempt to apply this explanation to all the remaining genera of Marchantiaceæ with the exception of *Targionia*, and to regard all male and female receptacles as resulting from the transformation of a branch, is certainly inadmissable as regards most male inflorescences, and is justified only for a portion of the female.

Leitgeb maintains that the Marchantiaceæ are descended from *Riccia*-like forms, and that they and the Ricciceæ belong without doubt to one and the same series of development. The following are the most important points relating to the development and position of the reproductive organs of the Ricciceæ:—

1. Both kinds of sexual organs have their origin immediately behind the growing apex. Hence they invariably stand on the dorsal side next the median line of the thallus, on the mid-rib, and are developed in acropetal succession; new organs never being formed further from the apex than those already in existence.

2. The mother-cells of the sexual organs at first project like papillæ above the surface; in consequence of the increase in thickness of the thallus, they subsequently appear as if imbedded in the tissue.

* 'SB. k. Akad. Wiss. Wien,' lxxxi. (1880) pp. 123-13.

In these points the Ricciæ agree with the Marchantiaceæ. The following relate to the variety in the development of the branches or portions of the thallus which bear the sexual organs.

3. The sexual organs of some species are associated in more or less sharply defined groups (inflorescences).

4. On their formation the growth of the apex is modified in various ways.

The following are described by the author as the different types of development of the male and female inflorescences of the Marchantiaceæ.

1. The sexual organs are scattered over the surface of the thallus; apical growth does not appear to be modified by their production. To this type belong the true Ricciæ ♂ and ♀; also *Clevea* (*Sauteria*) ♂; apparently also *Boschia* ♂.

2. The sexual organs are congregated in groups (inflorescences) recurring on the same axis; where receptacles occur, these are therefore purely dorsal structures:—*Corsinia* ♂ and ♀; *Plagiochasma*, *Fimbriaria*, *Reboulia*, *Grimaldia*, *Sauteria* (*Peltolepis*) ♂; with formation of true female receptacles:—*Plagiochasma*, *Clevea* ♀.

3. The inflorescences are also dorsal structures, but are placed at the apex of an unbranched shoot:—*Duvallia*, *Lunularia* ♂; *Targionia*, *Cyathodium* ♂ and ♀; with formation of a true female receptacle, from the enclosing of the apex of the axis:—*Duvallia*, *Reboulia*, *Fimbriaria*, *Grimaldia*.

4. The inflorescences correspond to an entire branch-system: *Lunularia* ♀; *Fegatella* ♂; *Marchantia* and *Preissia* ♂ and ♀.

The following is the course of development of the sexual organs in the Marchantiaceæ: — At first distributed over the surface of the thallus, they subsequently arise in groups, and become combined into inflorescences, which, having at first a dorsal position, are constantly pushed further back towards the apex of the axis, and enclose it in their growth, and thus dorsal inflorescences are converted into terminal. In those genera which dichotomize freely, the formation of the inflorescence commences at the moment of branching; and thus the entire branch-system aids in the formation of compound inflorescences.

In conclusion, the author states that the same course of development of the inflorescences may also be traced in the Jungermanniaceæ; and that it is highly probable that the same is true also of the Musci, notwithstanding apparent deviations.

**New Hepaticæ.***—The following new and critical species of Hepaticæ are described by Limpricht:—*Alicularia Breidleri*, *Sarcoscyphus confertus*, *S. commutatus*, and *Jungermannia decolorans*.

## Fungi.

**Observations on Uredineæ and Ustilagineæ.**†—G. Winter contributes the following observations to our knowledge of the life-history of some fungi belonging to these two families.

* 'JB. Schles. Ges. f. vaterl. Cultur,' lviii. See 'Bot. Centralbl.,' i. (1880) p. 866.

† 'Hedwigia,' xix. (1880) p. 105.

The question has been hitherto in debate whether *Phragmidium* has an æcidio-form. Fuckel states distinctly that no æcidio-form is known, but spermogonia; while Schröter describes the æcidio-fructification as similar to the uredospores; but without paraphyses. The author considers it possible, from his observations, that *Cæoma miniatum* and its allies, which are found abundantly on *Rubus* and other rosaceous genera, are the hitherto undiscovered æcidio-form of *Phragmidium*.

The æcidio-form of both species of *Puccinia* which are parasitic on *Caltha* are now known, and are developed on the same hosts. The following is their diagnosis:—*Puccinia Calthæ* Link. Æcidium maculas in foliorum pagina superiore luteas, dein fuscas, irregulariter rotundas vel elongatas, interdum confluentes, in pagina inferiore tuberculatas, 1–5 mm. longas formans. Ad petiolum calla elongata, ca. 6 mm. longa adsunt. Pseudoperidia irregulariter vel rarius concentrice disposita, patellæformia, parum emersa, margine lato revoluto multum inciso albescente prædita. Pseudoperidiorum cellulæ polygoniæ rotundatæ v. elongatæ, hyalinæ, membrana crassa, verrucosa, 22–35 $\mu$ diam. usque 45 rarius 60 $\mu$ longæ. Sporæ subrotundæ, plerumque polygoniæ, aurantiacæ, verruculosæ, 22–30 $\mu$ diam.—*Puccinia Zopfii* Winter. Æcidium ab antecedente margine pseudoperidiorum parum inciso, laciniis latis ca. 4–5 prædito; ad petiolum calla usque 15 mm. longa, sæpe confluentia adsunt.

The author also records the detection of the æcidium on *Mulgedium alpinum* which belongs to *Puccinia Prenanthis*, and of a *Puccinia* on *Senecio cordatus* apparently identical with the *P. conglomerata* on *Homogyne alpina*.

The same paper contains also other interesting observations on particular species belonging to this group.

**Uredo viticida.***—For about the last ten years the vineyards of Yonne have been devastated by a disease, somewhat similar to that produced by the oïdium, which as completely destroys the grape as does the phylloxera; but the distribution of the disease is much more limited. M. Daille has examined all the parts of the plant attacked, and establishes as the cause of the disease a fungus, *Uredo viticida*, mainly distinguished from oïdium by its spherical spores, and possessing a great similarity to the mildew of cereal crops.

**Development of the Spermogonia of Æcidiomycetes.**†—An examination by E. Ráthay of the spermogonia of a considerable number of Æcidiomycetes—*Puccinia Anemones*, *obtegens*, *Falcariæ*, *Tragopogonis*, *graminis*, *straminis*, and *coronata*, *Gymnosporangium fuscum*, *conicum*, and *clavariæforme*, *Uromyces scutellatus*, and *Æcidium Magelhaenicum* and *Clematidis*—shows that in almost all cases they contain a larger or smaller quantity of a substance which has the property of

* 'Journ. Pharm. et Chim.,' ii. (1880) p. 32. See 'Bot. Centralbl.,' i. (1880) p. 712.

† 'Vergel. k. Akad. Wiss. Wien; Sitz. math.-naturw. Cl.,' June 10, 1880. See 'Bot. Centralbl.,' i. (1880) p. 651

reducing, with the assistance of heat, Fehling's reagent. Since the contents of the spermogonia of *Gymnosporangium fuscum* and *conicum*, which contain the greatest quantity of this substance, have a strong sweet taste, Ráthay believes it to be sugar.

The part of the host where the sugar-producing spermogonia of the Æcidiomycetes are produced, is distinguished for a considerable distance around. Thus, in the case of the Æcidiomycetes with monocarpous mycelium, the small part of the host which is possessed by the mycelium, and on which the comparatively few spermogonia make their appearance, is marked by a remarkably bright yellow, orange, or red colour. And in the case of those with pleocarpous mycelium, in which an entire branch of the host is infected, and the spermogonia are numerous, breaking out either on all the organs of the infected branch or only on the leaves, these infected branches are doubly distinguished from the rest; firstly, by their peculiar appearance, due either to the pale colour of their green parts, and the unusual form of their leaves (like the shoots of *Cirsium arvense* attacked by *Puccinia obtegens*), or especially to their abnormally abundant branching and leafiness (like the "witch-broom" of the berberry caused by *Æcidium Magelhaenicum*), or to the suppression of the flowers (like the well-known sterile branches of *Euphorbia cyparissias* attacked by *Uromyces scutellatus*), and secondly by the sweet odour springing from the spermogonia, as occurs in branches affected by *Puccinia Anemones*, *obtegens*, *Falcariæ*, and *Tragopogonis*, *Uromyces scutellatus*, and *Æcidium Magelhaenicum*. When the spermogonia have ceased to produce sugar, their colour changes.

In damp or stormy weather, the contents of the spermogonia escape from their mouths in the form of small drops which adhere to the paraphyses; and these are eagerly sought for and consumed by various insects, such as ants and some Coleoptera and Diptera which are capable of taking up honey of this description, such as the honey-dew formed by aphides, the nectar of extrafloral nectaries, the honey-dew of ergot, &c.

The author draws a comparison between the phenomena connected with these male organs of the Æcidiomycetes, and the well-known ones associated with the flowers of flowering plants.

**Infection of Puccinia Malvacearum.***—By experiments carried on in the botanic garden at Giessen, Dr. Ihne confirms the previous statements of Cornu and Kellermann that this fungus can be propagated by direct infection on leaves of the same plant as that from which it was obtained, or of some other malvaceous species. The only plant on which the parasite made its appearance this year at Giessen was the hollyhock (*Althæa rosea*). From infected leaves it was directly conveyed by artificial contact to others on hitherto sound plants, and it spread also by spontaneous infection. Another plant belonging to the natural order Malvaceæ, *Kitaibelia vitifolia*, was also infected in the same way; but similar experiments on *Lavatera trimestris* were unsuccessful.

* 'Hedwigia,' xix. (1880) pp. 137–8.

**Alternation of Generations in Gymnosporangium.***—Oersted has already shown that the sporidia of *Podisoma sabinæ*, parasitic on *Juniperus sabina*, sown on *Pyrus communis*, give rise to *Rœstelia cancellata;* those from *Podisoma juniperinum*, parasitic on *Juniperus communis*, to *Rœstelia cornuta* when sown on *Sorbus aucuparia;* and those of *Podisoma clavariæforme*, parasitic on *J. communis*, to *Rœstelia lacerata* when sown on *Cratægus oxyacantha*, and to *R. penicillata* on *Pyrus Malus* (this last is, however, believed by the present writer to be an error).

A long series of experiments, conducted by Dr. E. Ráthay, have led him to the conclusion that:—1. The *Podisoma sabinæ* on *Juniperus sabina*, and the *Rœstelia cancellāta* on *Pyrus communis*, belong to the same species. 2. The *Rœstelia cornuta* on *Sorbus aucuparia* belongs to the *Podisoma juniperinum* on *Juniperus communis;* and that, contrary to expectation, to the same teleuto-form belong also the *Rœstelia penicillata* on *Pyrus Malus* and *Sorbus Aria*, and the *Rœstelia* on *Cydonia vulgaris*. 3. The *Podisoma clavariæforme* on *Juniperus communis*, the *Rœstelia lacerata* on *Cratægus oxyacantha* and *monogyna*, and a distinct *Rœstelia* found by the writer on *Pyrus communis*, and another on *Sorbus torminalis*, all belong to the same species. 4. No result followed from sowing the sporidia of *Podisoma sabinæ* on *Mespilus germanica*, *Cratægus oxyacantha*, *C. monogyna*, *Pyrus Malus*, *Sorbus Aria*, or *S. torminalis;* or those of *P. juniperinum* on *Mespilus germanica*, *Cratægus oxyacantha*, *C. monogyna*, *Sorbus domestica*, or *S. torminalis;* or those of *P. clavariæforme* on *Mespilus germanica*, *Pyrus Malus*, *Sorbus domestica*, or *S. Aria*.

In order to simplify the nomenclature, Oersted united these series of teleuto-forms and æcidio-forms into the genus *Gymnosporangium;* and to the three species occurring in Denmark he gave the names *G. fuscum*, *conicum*, and *clavariæforme*, corresponding to the teleuto-forms *Podisoma sabinæ*, *juniperinum*, and *clavariæforme*.

E. Ráthay states that the teleutospores of *P. clavariæforme* are mature earlier than those of *P. sabinæ* and *juniperinum;* and that the same is the case with regard to the maturity of the spermogonia and æcidia of the corresponding æcidio-forms. He gives the following table of all the species on which both forms of the three species have at present been found to be parasitic:—

| | Hosts of Teleuto-form. | Hosts of Æcidio-form. |
|---|---|---|
| *Gymnosporangium fuscum* DC., Oerst. | *Juniperus sabina* L. | *Pyrus communis* L. |
| *Gymnosporangium conicum* DC., Oerst. | *Juniperus communis* L. | *Sorbus aucuparia* L.<br>*Aronia rotundifolia* Pers.<br>*Pyrus Malus* L.<br>*Sorbus Aria* Crtz.<br>*Cydonia vulgaris* Pers. |
| *Gymnosporangium clavariæforme* DC., Oerst. | *Juniperus communis* L. | *Cratægus oxyacantha* L.<br>*Cratægus monogyna* Jacq.<br>*Pyrus communis* L.<br>*Sorbus torminalis* Crtz. |

* 'Oesterr. Bot. Zeitschr.,' xxx. (1880) pp. 241–4.

**Conidial Apparatus of Pleurotus ostreatus.***—Specimens of this fungus gathered in the woods of Meudon on Feb. 1st last, exhibited the following peculiarities of structure.

The development of these specimens had taken place under unfavourable conditions, in consequence of the severe cold of January, which caused such an exuberant growth of the capillary system that the fungus, which ordinarily possesses only short hairs, and these usually very few, on the pileus and the stipes, was entirely covered with a dense white down.

The hairs which constituted this down were composed of two or three cells with granular contents and with a swelling at each articulation. The hairs were ordinarily distinct; but sometimes two or three had coalesced either at the apex or at the point of contact of two lateral walls, or finally by means of a kind of bridge.

The hairs on the centre of the pileus and on the stipes appeared to be always sterile, while those on the edge of the pileus were shorter and often sporiferous. These spores are ovoid, colourless, thin-walled, and contain one or two vacuoles; they are borne on a short sterigma. Each hair bore one or two spores, but there was never more than one attached to a single cell. The spore might be exactly terminal, or near the summit, or altogether lateral.

The fertile basidia appeared to be less abundant than usual in these specimens.

**Ptychogaster albus, Cord., a Form of a Polyporus.**†—This fungus has been variously assigned to the Myxomycetes, Gasteromycetes, and Hymenomycetes; and has been considered as a stage of development of another fungus. T. Ludwig has now set the question at rest by the discovery of a second mode of fructification.

On the entire under side or on free spots of it, it sometimes forms *Polyporus*-tubes, or the hyphæ display an evident tendency to collect into tubes. Sections through the fungus do not bring out, even under the Microscope, any difference between this layer and the rest; both consist of similar hyphæ. The *Polyporus* tubes are of moderate size with angular or roundish mouth, where they have a few sharp teeth, the extremities of hyphæ which project beyond the mouth.

On the spots inhabited by the *Ptychogaster* no other species of *Polyporus* was found. Ludwig regards it therefore as an independent and new species, most often propagated by conidia and but rarely by the *Polyporus*-fructification, and describes it under the name *Polyporus Ptychogaster*. The phenomenon is analogous to that in *Fistulina hepatica*, in which De Seynes discovered a conidial generation, as did Eidam and Van Tieghem in some species of *Coprinus*.

**Synchytrium parasitic upon Dryas.**‡—Dr. F. Thomas records the discovery, in the Tyrolean Dolomites, of a parasitic fungus forming galls on the leaves of *Dryas octopetala*, which he identifies

* 'Bull. Soc. Bot. France,' xxvii. (1880) p. 125.

† 'Zeitschr. für d. Ges. Natur,' 1880, p. 424. See 'Bot. Centralbl.,' i. (1880) p. 865.

‡ 'Bot. Centralbl.,' i. (1880) p. 763.

with *Synchytrium Myosotidis*, Kuehn, distinguishing it as the var. *Dryadis.* The spherical, ovoid, or flask-shaped cells which conceal the parasite resemble large golden-yellow or reddish-yellow glands emerging above the epidermal layer; they are more abundant on the upper than the under surface, often so closely packed as to form a kind of incrustation; they also occur on the leaf-stalks, stipules, and sepals, less often on the flower-stalks. Each of these abnormally swollen cells contains one, or less often two spores. The tissue of the infected leaf undergoes the ordinary hypertrophy.

**New Vine-disease.*** — Under the name "Herbstbrenner" Dr. Kübler describes a disease of the vine which shows itself in the rapid fall of the leaves, resulting from warm sunshine after a cold autumn rain, causing some of the cells of the leaves to burst, and the fluid contents to flow into the intercellular spaces, and there decompose. The products of decomposition give rise to a fungus which develops with great rapidity into brown tufts on the upper surface of the leaf; and entire vineyards lose their leaves in a few days. The fungus consists of a white mycelium with fertile threads which bear bilocular spores grouped in tufts. The author proposes for it the name *Cladosporium autumnale.*

With regard to *Oïdium Tuckeri* and *Sphaceloma ampelinum*, Dr. Kübler considers that they are not the causes of the well-known vine-diseases, but the result of unhealthy conditions of soil, climate, &c.

Pfau-Schellenberg disputes this last conclusion of Kübler; but confirms his observations with regard to the *Cladosporium autumnale.*

**Clover-disease in Sweden.†**—A very destructive disease first made its appearance on the clover-crops in Hesse in 1857, since spreading into Denmark and Sweden. Its history and cause have been closely investigated by J. Eriksson, who attributes it, as previous observers have done, to the ravages of a parasitic fungus. He does not, however, agree with H. Hoffmann, in identifying the parasite with *Peziza ciboroides* Fr., from which it differs both in the time of year at which it appears, and in other respects. The writer proposes for it the name *Peziza* (*Sclerotinia*) *trifoliorum*, and considers it nearly allied to *S. homocarpa* Karst. The form in which the fungus attacks the clover is that of a sclerotium; but its propagation the writer considers due to hyphæ which become attached to the clover-seeds.

**Salmon Disease.‡**—The subject of the salmon disease still occupies the attention of the Fishery Commissioners, and a paper on the subject has been read at the Dumfriesshire Natural History Society, in which it is maintained that the disease is aggravated, if not caused, by the presence of a vast number of *Bacteria* in the flesh of the diseased spots.

Mr. Rutherford writes:—"Sections of the muscle, when placed under the Microscope, were seen to be literally one mass of life; that

* 'Arch. Sci. phys. et nat. Genève,' 1879, p. 456. See 'Bot. Centralbl.,' i. (1880) p. 298.

† 'K. Svensk. Landtbr. Akad. Handl. och Tidskr.,' 1880. See 'Bot. Centralbl.,' i. (1880) p. 296.

‡ 'Grevillea,' ix. (1880) pp. 9–10.

life being a species of *Bacteria*. They are small discoid-looking bodies, which in this case I find imbedded in, and moving amongst, the striated muscle-fibre of the fish, and when, by pressure or otherwise, they are forced into the surrounding fluid, they have a power of motion, moving mostly in a sort of circular direction. In some fish that I have examined, I observed that the muscle was almost detached from the strong fibro-muscle layer of the skin, and the muscle fibres of that layer were not adhering together as in their natural state, and could be separated from each other like threads by the needle. Whether that diseased condition of that part of the skin was caused by the muscle immediately below it, or by the fungus on the surface, I am not in a position to say." Afterwards he says :—"The disease was located in the muscle of the fish, and I also have some idea that it will be found to commence in the blood, caused either by the food they eat, or by some deleterious solution in the water which passes through the gills; and that the unhealthy decaying fluid or matter which will naturally pass off from those *Bacteria*, and exude through the pores of the skin, forms a healthy and proper nidus for the germination of the zoospores of the fungus, which must be in those affected rivers in myriads."

It would be some consolation to the mycologist if, after all, he could feel convinced that this fatal salmon disease was not primarily caused by the *Saprolegnia;* but Dr. M. C. Cooke considers that "there are very grave doubts whether these *Bacteria* are not more probably the result of a certain disintegration of the substance of the flesh caused by the mycelium of the *Saprolegnia*, than a preliminary depravity of the flesh inducing the subsequent development of the fungus. However much we may dislike the conclusion that a fungus is the principal cause of so much mischief, I fear that we must accept the force of evidence which goes to show that the *Saprolegnia* appears to be the great destructive agent in this disease. It may be true, and undoubtedly is, that the constitution of the fish is in a low condition, that it is debilitated, and powerless to resist the fungoid attacks; and that this condition may be the result of various secondary causes; but the theory that *Bacteria* in the fish is the primary cause, though it may be a new suggestion, can scarcely be accepted as a true one. The coincidence should be borne in mind, even if it is no more than a coincidence, that in all the great instances of devastating fungal diseases, there has been an undoubtedly weakened constitution in the subject, caused by over-cultivation, and in-breeding, preliminary to the attacks. Such was the case with the silkworm, and it fell a prey to 'muscardine'; in the potato, and it succumbed to the *Peronospora;* in the vine, and it became the victim to *Oidium*. May we not add also, in the salmon, ere it was devastated by the *Saprolegnia?* and it may yet be to the onion in Europe, and the poppy in India, unless the threatened misfortune should be averted."

**Biology of the Schizomycetes.***—H. v. Boehlendorff has applied Bucholtz's method of investigating the life-history of the Schizomy-

* Boehlendorff, H. v., 'Ein Beitrag zur Biologie einiger Schizomyceten. Inaug.-Dissert.' Dorpat, 1880. See 'Bot. Centralbl.,' i. (1880) p. 692.

cetes, especially to the albumen-bacteria. The nutrient fluid employed was hard-boiled white of egg pounded in a mortar and then boiled for an hour. The milky fluid thus obtained was preserved free from bacteria for weeks by a carbol-wad. In order to obtain the bacteria, he allowed a small, clean, strongly-heated glass, into which a small quantity of the fluid had been poured, to stand exposed. In the space of twenty-four hours, numerous rods had made their appearance in it; the sulphuretted hydrogen reaction set up from five to eight days later. The progressive development of the bacteria was observed partly in the decoction of albumen placed in a hatching-oven, partly in solutions of albumen infected with fresh bacteria, and protected by a wad-stopper, also placed in the hatching-oven.

On the first day there were seen only small motile spherules and rods; on the following days the rods had increased in size, the spherules had disappeared. The rods were partly free and motile, partly collected into zooglœa-colonies. The sulphuretted hydrogen reaction began with the formation of zooglœa, increased for five or ten days, and then again decreased. As this evolution increased, the zooglœa-colonies again always dispersed, and the rods gradually disappeared, breaking up into strongly refractive spherules. When the evolution had ceased, the spherules often again grew into rods, and the development began afresh. There was a difference in the result according as fresh albumen-bacteria or bacteria from a solution in which sulphuretted hydrogen had already begun to be produced, were placed in the albumen-decoction. In the latter case the sulphuretted hydrogen reaction was manifested on the second day, in the former generally not till the fifth. In two cultures, bacteria from a fresh solution containing no sulphuretted hydrogen, and secondly from one in which the gas was being abundantly developed, and in which there were already a number of rods, were sown in boiled and unboiled milk, in boiled urine, and in a decoction of ergot.

It was now seen that the stage of development of the bacteria influenced the process of decomposition in the new nutrient fluid. The young bacteria merely turned the milk sour or somewhat accelerated the acidity; the more vigorous old bacteria, which had already caused a production of sulphuretted hydrogen in the albumen-solution, produced the same reaction in the fluid; they continued to develop, while the young bacteria were more indifferent, or altogether perished. In fresh milk no effect was produced; the natural ferment acted quicker and more strongly. In urine the older bacteria always produced alkalinity more rapidly than the younger ones; in ergot-decoction both soon perished. He also introduced the bacteria from putrefying blood, tobacco- and pea-decoction into a great variety of nutrient fluids.

The general results arrived at were that (1) the Schizomycetes from the same generating substances, when introduced into different nutrient fluids, present great variation in their development; and (2) Schizomycetes from different generating substances, introduced into one and the same nutrient fluid, also develop differently, and in part produce also different decompositions; and hence that both the generating substance and the nutrient fluid influence the growth and the vigour of bacteria.

Further experiments were made by the author with the bacteria of sour milk. He found in it the sphæro-bacteria described by Pasteur, whose developments he followed out. Sowings in different nutrient fluids also produced a more or less abundant growth of them. In boiled urine they developed with especial vigour; but after a fortnight the alkaline fermentation was not produced; while by the bacteria of urine it was brought about in a few days. In urine there arose spontaneously at first small spherules, succeeded by small rods, which at length developed into long filaments and vibrios. The experiments made with these urine-bacteria, which he placed in the most various nutrient fluids, gave very different and partially irreconcilable results, so that the author was led to the conclusion that a variety of bacteria arise spontaneously in urine, one of which often smothers another.

Finally, he followed the development of bacteria-sowings from various generating substances in unboiled flesh-water and in Bucholtz's fluid, in boiled flesh-water, solution of peptone, and solution of isinglass. The peptone-solution, which he strongly recommends for bacteria-culture, he made of 0·08 gr. pepsin, 4 cc. 33 per cent. hydrochloric acid, and 20 gr. fibrin in 400 cc. distilled water, leaving the mixture some hours in a warm place until the fibrin was dissolved, the solution then neutralized with ammonia, filtered, and finally sterilized by boiling. The solution, which is at first turbid, soon becomes perfectly clear from an abundant white precipitate of parapeptone; and the presence of bacteria can then be recognized without the Microscope by the turbidity which always again results.

The following are given by the author as the most important results obtained :—

1. He believes in the existence of a number of different species of bacteria.

2. He considers the fact that no development takes place in Bucholtz's solution to be no proof that active bacteria and bacterial germs are not present in a sowing.

3. Sphæro-bacteria are partly independent forms, partly stages of development of bacillar bacteria.

4. The spontaneous infection of the nutrient fluid usually takes place from the access of spores from the atmosphere, and not from the water used in the fluid.

5. The final results of the development of bacteria are strongly refractive, longish oval resting-spores.

6. The nutrient fluid employed is not a matter of indifference.

**Influence of Schizomycetes on the Development of Yeast.***— According to experiments carried on by M. Hayduck, the presence of Schizomycetes exercises an injurious influence on the propagation of yeast and the process of fermentation. The cause is probably simply

* 'Zeitschr. f. Spiritusindustrie,' iii. (1880) p. 202. See 'Bot. Centralbl.,' i. (1880) p. 866.

that the former remove from the nutrient fluid the substances which serve for the nutrition of the latter. On fully developed torula-cells they appear to have no injurious influence.

**New Microscopic Schizomycetes.***—V. A. Poulsen describes an organism discovered by him belonging to the family Sarcineæ of Schizomycetes, which he treats as a new genus and species under the name *Sarcinoglobulus punctum*. It differs from the genus *Sarcina* in its spherical form and numerous cells. It occurs in sea-slime from which sulphuretted hydrogen is given off. In similar situations he found also a new species of *Sarcina*, *S. litoralis*.

*Chlamydomonas hyalina* Cohn is also described again in detail, and the old name *C. uva* restored.

**Social Bacteria.**†—M. P. Van Tieghem remarks that in the family of Bacteriaceæ, the cells, whatever their form, spherical, cylindrical, or spiral, are disposed in a variety of ways. Sometimes they are arranged in a linear series, in the order in which they have increased or divided, so as to form long threads of beads (*Micrococcus ureæ*, *bombycis*, &c.), or cylindrical (*Bacillus anthracis*, the young state of *B. amylobacter*, &c.) or spiral filaments (*Spirochæte*), This is the typical disposition, and is sometimes modified by the formation of a gelatinous sheath either around the whole mass of cells (*Myconostoc*), or each separate cell (*Leuconostoc*); but this does not affect the arrangement of the cells in a linear series, which is often contorted and knotted on itself.

Sometimes, on the contrary, the cells separate immediately after segmentation, without preserving any mutual relation as to direction. Then they either disperse in the surrounding medium without maintaining any connection, or they secrete a gelatinous substance which keeps them united in more or less considerable masses altogether indeterminate in form (several species of *Micrococcus*, *Bacterium*, &c.).

This permanent association in a linear series, and this immediate dissociation into separate cells, present various connecting links, which render the characters difficult and doubtful of application in the definition of genera and species. This does not appear to be the case with a third mode of existence, which the author terms *social* (*agrégée*).

Under these conditions the cells, spherical or rod-shaped, become completely dissociated immediately after the division by which they have been formed, turn and glide one over another, and remain in intimate contact, cemented together apparently by a gelatinous substance. Starting from a spore or primitive cell, there is thus gradually developed a compact mass, with more or less sharp outline, which soon assumes a definite form, spherical, oval, or cubical, and which increases by repeated and simultaneous bipartition of the cells of which it is composed. When it has attained a certain dimension, it divides into two equal halves, which separate slightly,

* Poulsen, V. A., 'Ueber einige mikroskopische Pflanzenorganismen.' See 'Bot. Zeit.,' xxxviii. (1880) p. 509.

† 'Bull. Soc. Bot. France,' xxvii. (1880) pp. 148-153.

increase so as to resume their primitive form, and then in their turn divide when they have reached their full size. Sometimes the entire mass is naked; its contour is formed simply of the extremities of the peripheral cells which are bound together by the interstitial gelatinous substance. Sometimes, on the contrary, it is enveloped by a resisting membrane of a gelatinous appearance, which, after each augmentation of the contents, develops between the two halves, and then divides so as to clothe them completely and independently after their separation.

The segmentation of the entire body takes place either in one direction only, and the small masses remain, at least for a time, united like bead-work, or in two directions in the same plane, and the masses spread out side by side in the form of a membrane; or finally, in three directions, and the masses are superposed in a solid mass, and form nodules of a smaller or larger size.

Thus are formed aggregations of cells, derived from one primitive parent cell, and following henceforth a common law; and these cells, in their form, their mode of increase, their successive divisions, and the relations which they maintain towards one another, behave like so many simple cells, sometimes naked, sometimes enveloped in a membrane. They constitute, in fact, cells of a second order, composite cells, something like those compound bodies which, in chemical combinations, play the part of simple bodies. By careful crushing, these colonies can be decomposed; when the isolated cells, continuing to increase as when they formed part of the colony, soon again constitute new societies, which again carry on their normal development.

In further investigating the form of the primitive cells, the form of the colonies, or cells of the second order, the presence or absence of a general membrane, and the relative disposition of the colonies after their division, characters may be obtained of a certain number of genera and species; and the author proceeds briefly to define the types best known to him, and the development of which he has been able to follow. They arrange themselves in two groups, according as the colony is or is not provided with an enveloping membrane.

1. Naked Colonies.—The colony is composed either of cylindrical cells similar to those of *Bacterium* and *Bacillus*, or of spherical cells similar to those of *Micrococcus*. The former are united into the genus *Polybacteria*, the latter into the genus *Punctula*.

*Polybacteria*.—In the decoction of horse-dung which is frequently employed for the production of fungi, M. Van Tieghem has often met with a *Polybacteria*, in which the naked, colourless, oval colonies, composed of small rods aggregated in every variety of way, always divide transversely in the same direction, and remain end to end in the form of a frequently sinuous chain. This chain proceeds from the increase and division of a single mass, and this primitive mass is again entirely derived from a spore or a rod, as the writer has many times demonstrated by tracing the development of this minute organism in cell cultures, which is not unattended with difficulty. It may be called *Polybacteria catenata*.

In another species the rods are of a sulphur-yellow colour, the colonies rounded or polyhedral, and segmentation takes place in two directions at right angles to one another. When placing themselves side by side in the same plane, they form a sort of membrane, but without adherence. This is *Polybacteria sulphurea*. It was found on the surface of a liquid in which haricots were rotting.

*Punctula.*—The spherical cells are ordinarily extremely minute; they appear like innumerable dots united by a gelatinous cement. A close examination is required to distinguish the colonies composed of them from simple naked cells consisting of a finely granular protoplasm.

In *Punctula rosea* the colonies are of a bright rose colour; they are spherical, and with a sharply defined outline; the dots, which are so many elementary cells, are arranged in them with perfect regularity in radial rows and concentric circles. After each division, the two halves of the colony become rounded off, and separate completely. When one of these spheres is crushed, it is resolved into its elementary cells, and the formation can then be followed of so many new colonies by the repeated increase and division of each of the cells.

In *Punctula cubica* the slightly larger cells are colourless, and are associated together in cubical masses. After attaining a certain dimension the cube divides successively in directions parallel to its three faces, and each new cube behaves in the same way. At least for a time, all the cubes are associated together in larger or smaller cubical masses.

In *Punctula glomerata* the colourless colonies are rounded into spheres, divide in three directions, and remain thenceforth associated in larger or smaller mamillated masses.

These three organisms have been found at various times on seeds in a state of putrefaction.

2. Colonies provided with a Membrane.—In this group must be placed the genus *Ascococcus* of Cohn, composed of spherical cells, which is nothing but a *Punctula* invested. The types with cylindrical cells may be combined into the genus *Ascobacteria*, which again may be described as a *Polybacteria* invested.

*Ascobacteria.*—On the surface of liquids in which were rotting seeds of various leguminous plants, and especially lupine, the writer frequently found small, granular, polyhedral masses, each enveloped in a thick cartilaginous membrane, placed side by side in a strongly adherent layer, after the manner of an *Ulva*. But the contents of each compartment, instead of being a simple protoplasmic body, were composed of a great number of small rods, inclined in all directions, and intimately united by a kind of cement. After having attained a certain dimension by repeated and simultaneous bipartition of the rods, it splits into two, and the gelatinous membrane is continued over the two new surfaces. When the mass is crushed, the rods are set free and dissociated; they then develop, as they did within the mass, and soon give rise to as many new colonies, each of which soon becomes surrounded by its own membrane, or constitutes a cell of the second order. Van Tieghem has denominated this organism *Ascobacteria ulvina*.

*Ascococcus* Cohn.—In *Ascococcus Billrothii* Cohn, as in the three species of *Punctula*, the excessively minute cells of the colony are immobile. They are so closely bound together by a firm cement as not to be easily separated. This is not the case with another species of *Ascococcus* which the writer met with on the surface of water containing various aquatic plants, where *Beggiatoa* was putrefying, and which exhaled a strong odour of ammonia sulphohydrate. Here the cells, also extremely minute, moved with a very rapid oscillating and whirling motion in the interior of the membrane, and having all the appearance of a Brownian movement. Hence this species has been termed *Ascococcus vibrans*.

All the social bacteria hitherto described are aërobes, producing an energetic combustion in albuminoid substances on the surfaces of which they are formed, and often, if not always, disengaging a large quantity of ammonia, a phenomenon which Cohn has already described in the case of *Ascococcus Billrothii*.

From the observations above described, M. Van Tieghem deduces a confirmation of his view already published that the cell cannot in any sense be regarded as an element. It may, in fact, be split up, a fragment may be separated from it, and this fragment, when placed in favourable conditions, will retain all the properties of the entire cell, and will be able to regenerate it. The plant itself also carries on at every moment this splitting up of its cells into similar and complete parts, often very numerous and minute. It is indeed on this division that all increase and reproduction depend. The protoplasmic body of a cell is then, in fact, an assemblage of similar parts, each complete in itself, which may be isolated artificially, and which separate from one another naturally by the processes of growth and reproduction, although these parts are actually in continuity with one another, and subject to a common law of development. In a large cell there is a great number of these similar parts, and a great number of fragments can be cut off from it, equivalent among themselves and to the entire cell. In a small cell there are fewer such parts. Finally, when the cell is reduced below the size measurable with precision by our existing instruments, the fact that it still divides is clear evidence that it can no longer be regarded as an irreducible element. The analysis of the cell shows, therefore, that it is not, as has generally been stated, the formative morphological element of organisms.

These observations on social bacteria lead, in another way, by a synthetic path, to the same conclusion. We see, in fact, in them, small cells springing from a primitive cell, and grouping themselves into an intimate association governed by a common law of growth; this association assuming a definite form and dividing in a certain manner when it has attained a certain size, and then multiplying and maintaining each time its new parts formed in a certain relative position. In one word, this association of similar cells behaves in all respects like a simple cell; it is, in fact, a compound cell. When crushed, each part is able, like a simple cell, to exist independently, and to regenerate the entire colony. There is, however, one difference. This crushing only effects a separation of the cells which have been seen to form themselves and to become agglomerated in order to constitute the compound cell, while in a simple cell the detached fragments have no known origin nor precise morphological significance.

The increase of the body of the compound cell, resulting from the repeated and simultaneous bipartition of its several cylindrical or spherical cells, closely resembles the mode of increase of so many constituent parts of the protoplasmic body of a simple cell, for example, of the chlorophyll-grains or nuclei. The recent researches of Baranetzky * have shown that the nucleus is composed of elements bearing the form of rods, and that it increases by the elongation and repeated bipartition of these rods, just as bacteria do; and that it is this increase itself which, not being able to pass a certain limit, brings about the division. Between a nucleus thus constituted and the body of a compound cell of a *Polybacteria* there is a striking resemblance. One day it will perhaps be demonstrated that this similarity of constitution and of growth extends to the whole of the protoplasm of the simple cell.

A blow is thus, in the opinion of M. Van Tieghem, struck at the view of the cell as an element, whether morphological or physiological, and at the foundation of the cell-theory.

**Development and Fermenting Power of Bacteria.**†—Prazmowski has specially studied the development and properties of the genera *Bacillus* Cohn, *Clostridium* Prz. n. gen., and *Vibrio* Cohn. Of *Bacillus subtilis* Cohn, he has closely followed both the germination and the formation of the spores. He believes it to have no fermenting power, since it dies the moment it is deprived of oxygen. *B. Ulna* was found by him in rotten eggs, and in the spore-producing state, but he was not able to connect it with the process of decay.

The butyric ferment, or "vibrion butyrique" of Pasteur, is known under the various names of *Amylobacter Clostridium*, *Urocephalum* Trécul, *Bacillus Amylobacter* v. Tiegh., and *Bacterium Navicula* Reink. et Berth. The author establishes from it a new genus *Clostridium*, of which two species are described. The first, *C. butyricum* (*Bacillus Amylobacter* v. Tiegh.) is completely anaerobic, the spores germinating at one end, instead of, as in *Bacillus subtilis*, in the middle. The second species, *C. Polymyxa* Prz., is new, though closely resembling *C. butyricum*, is almost entirely aerobian, and can only produce its spores under access of oxygen; when air is excluded, it incites fermentation, but soon dies.

*Vibrio Rugula* Müller has only been found by the author along with other bacteria; the formation of spores was observed, but not germination. It decomposes cellulose.

The formation of jelly or zoogœa-condition of bacteria is believed by Prazmowski to indicate an affinity with the lower Algæ.

With regard to the anatomy of the spores, he states that they are

* See this Journal, *ante*, p. 976.

† Prazmowski, A., 'Untersuch. über die Entwickelungsgeschichte u. Fermentwirkung einiger Bacterien-Arten.' Leipzig, 1880. See 'Bot. Zeit.,' xxxviii. (1880) p. 523.

certainly surrounded by a cell-wall, but disputes the statement of Brefeld that they possess an epispore and a clear intermediate space.

**Effect of Putrefactive Changes on Bacteria.***—In all solutions containing *Bacteria* a time arrives when they cease to propagate, and after a longer time they lose their power to induce further life in fresh nutrient solutions. The admitted fact leads to the belief that the putrefaction induced by *Bacteria* produces substances which are poisons to these organisms.

Experiments have been made by Dr. Wernich on meat extracts of various ages with phenol, skatole, indole, and other putrefaction-products, all of which were found to exercise an injurious effect on *Bacteria;* moreover, substances most disposed to putrefaction were easily preserved from it by means of any of them in fresh solutions which were purposely impregnated. The addition of trifling quantities of these matters promptly caused inactivity of the *Bacteria*, and the author considers he has fully proved the truth of Baumann and Nencki's propositions on the subject.

The experiments in question lead to the solution of a highly interesting problem in pathology. The author says that the same or similar operations are carried out in the progress of septic diseases; the supposition that the organisms which are the cause of infectious diseases give rise to products which eventually cause their own destruction, is the only way in which the progress of these diseases can be properly comprehended. Many diseases, such as small-pox, measles, scarlet and relapsing fever, which are now generally ascribed to the presence of *Bacteria*, progress so peculiarly and take such a regular course that one is forced to believe that, with the cause of the malady, its own distinctive poison is produced in the same manner as in the experiments here noted.

**Theory of Virulent Diseases and the "Fowl-Cholera."**†—The view that the infectious diseases, such as measles, scarlet fever, small-pox, syphilis, splenic fever, yellow fever, typhus, and others, are connected with the presence and operation of organized ferments, the communication of which from one individual to another constitutes the infection, has lately met with increasing support. Hitherto, however, except in the case of splenic fever, direct and conclusive proofs of this hypothesis have not been forthcoming; but in the instance named the bacteria which cause it have been discovered, and their mode of action so far determined that it is possible by their means to produce the disease whenever desired. Very recently M. Pasteur has been able to rear the organism which is the cause of another disease, and to study its biological peculiarities. As the investigation throws light on the mysterious question of the immunity of individuals from a given contagious disease from which they have recovered, the facts elicited may be given more at length.

* 'Bied. Centr.,' 1880, pp. 224–6. See 'Journ. Chem. Soc.,' Abstr. xxxviii. (1880) pp. 726–7. See also this Journal, *ante*, p. 314.

† 'Comptes Rendus,' xc. (1880) pp. 239–48. Cf. 'Naturforscher,' xiii. (1880) pp. 117–18; also Prof. J. Lister's address to Annual Meeting of British Medical Association at Cambridge, 'Brit. Med. Journ.,' 1880, pp. 363–5.

A disease, usually known as hen-cholera, sometimes appears with very disastrous effects among fowls. The animal attacked by it is extremely prostrated, the gait is irregular, the feathers become erect, the wings droop, a heavy somnolence comes over it, ending in a quiet death: perceptible alterations are also caused in the internal organs. The observations of Messrs. Moritz, Peroncito, and Toussaint have shown it to be caused by a microscopic form of life, the last-named observer having proved by direct cultivation of it in neutral urine that it is the origin of the poisoning of the blood.

M. Pasteur had not the same success in his attempts at rearing it pure in neutral urine, but found a very favourable medium for the purpose in a broth made from fowls' muscle, neutralized by potash and heated to from 110° to 115° C. so as to sterilize it. The organism multiplies in this liquid with such rapidity that in a few hours the most transparent solution commences to be clouded, and is filled with immense numbers of minute and extremely delicate oval-shaped structures slightly constricted in the middle, and appearing at first sight like isolated points. Their transverse diameter is from $\frac{1}{50000}$ to $\frac{1}{25000}$ inch. They have no independent movements, and it is certain that they belong to a group quite distinct from the Vibriones. These microbia of the fowl-cholera present the striking peculiarity of rapidly perishing in yeast-liquid (although the Bacteria of splenic fever flourish admirably and reproduce in this fluid); for in less than twenty-four hours they have all died, while any foreign bodies accompanying them continue their own growth; this liquid therefore furnishes a valuable reagent by which to ensure the purity of growths which may be introduced into the solution of fowls' muscle.

If guinea-pigs are inoculated with this organism, an exclusively local injury is caused, especially at a certain age; this ends in an abscess of greater or less size. If the abscess opens of itself, it heals up without having caused the animal the least harm; it may persist for several weeks, and in this case is found full of a cheesy pus containing quantities of the microbion among the pus-cells. Here it lives as in a closed vessel, without injuring the animal; it remains very pure, and does not lose its vital powers. On inoculating fowls with the contents of the boils, they are found to die very quickly; the guinea-pig may also die from its effects, but only when under special circumstances the matter passes into the blood or the intestines. It sometimes happens that fowls or rabbits living with the infected guinea-pigs suddenly become ill and die without the health of the latter suffering in the least; it is only necessary for some of the abscesses to open spontaneously and a portion of their contents to reach the food of the rabbits or fowls. Without a knowledge of the relations thus made known, one would scarcely suppose the healthy guinea-pigs to be the cause of the decimation of their neighbours, but would rather believe a spontaneous disease to be its origin.

In order to cause infection, it is only necessary to place a few drops of a crop of the organism on the bread or meat given as food to the fowls; it undergoes so rapid a development in their alimentary canal that their very excrement when used to inoculate other individuals, is sufficient to cause their death; and this is doubtless the manner in which this disease is spread through the fowls inhabiting any one yard. The isolation of the sick from the sound birds, together with the most careful cleansing of the yard and the maintenance of it in a clean state, will certainly suffice to put a stop to the spread of the malady.

The repeated cultivation of the microbion in fowls'-broth by impregnating each successive liquid with an infinitely small quantity of the preceding liquid, weakens in no degree the poisonous properties of the agent. Its virulence is so great that inoculation by a very small portion of a drop of one of the growths thus reared causes death in every instance within two to three days, and very often within twenty-four hours. It is possible by certain modifications of the method of cultivation to bring about a mitigation of this virulence. The occurrence of this mitigation is marked by a slight retardation of the development of the microbion, "but in reality the two kinds of poison are identical. In the first, the most deadly condition, the microbion may cause death twenty times in twenty cases of inoculation; in the second, out of twenty cases of inoculation it causes twenty cases of disease, but never death. These facts have an importance which is readily appreciable; they allow us, in fact, to decide the problem of the recurrence or non-recurrence of the disease now in question. If we take forty fowls and inoculate twenty of them with a very poisonous specimen of infecting material, the twenty fowls die; if we inoculate the remaining twenty with weakened poison, they become one and all ill, but will not die. If we now let them become well again, and inoculate these twenty fowls with the most poisonous substance, it will now no longer kill them. The conclusion to be drawn from this is clear; the malady is a safeguard against itself. It has the characters of the infectious diseases, which do not recur."

At this point M. Pasteur reminds us that, of course, this fact is of itself nothing new, for man has long been successfully protected against small-pox by inoculation with cow-pox, the sheep in some places against hoof-disease, the cattle against the rinderpest, and it is also well known that people who have passed through measles, scarlet fever, syphilis, &c., are not again attacked by these diseases. The new and important point about the cholera of fowls is this, that we have found the infecting agent in this disease to consist of a microscopic parasite, which may be cultivated outside the body, and which not only evokes the disease, but also affords immunity against the effects of a repeated inoculation as distinctly as the contagious diseases.

The following passage of M. Pasteur's memoir qualifies slightly the conclusion arrived at above:—

"I do not wish to have it believed that the facts present the mathematical exactness and regularity which I have described. That is, my statements do not take account of the great variability which is accidentally presented by the constitutions and general vital powers of individuals taken from a collection of domestic animals. No, the most active poison of the fowl-cholera does not always kill twenty times in twenty cases, but in the observed cases which I have seen with my own eyes, it has killed at least eighteen times out of twenty in those instances where it has not killed twenty times. Similarly the poison which has had its violence diminished has not always preserved life twenty times out of twenty cases; in the cases of inferior protection this occurred sixteen or eighteen times out of the twenty. Further, it does not absolutely and by a single inoculation prevent a recurrence of the disease; this non-recurrence is attained much more surely by two inoculations than by one."

Since M. Pasteur's first experiments, he has investigated the conditions of immunity more fully, and has arrived at the following hypothesis of the real nature of the protective operation and the reasons for the immunity.*

Numerous experiments had shown that the inoculation with the weaker poison (which on the grounds of analogy and simplicity is named *vaccination*) gives such different results with different fowls, that in one case one vaccination is sufficient to cause entire immunity against the deadlier poison, while in others a once- and even twice-repeated vaccination is necessary. To illustrate this, let eighty fowls be taken, and twenty of them be inoculated with the violent poison, these twenty will die; inoculate the next twenty with the mitigated poison and none of them will die; if these twenty fowls which have once undergone vaccination be inoculated with the stronger poison, about six or eight will remain alive. A fresh series of twenty fowls may be vaccinated on two occasions, one operation to follow the other after an interval of seven to eight days, and inoculation with the deadly poison is now without danger to from twelve to fifteen of the number. If a batch of twenty new fowls is now vaccinated three or four times in succession, the inoculation with the powerful poison will cause neither the death or even the sickness of any more. In this last case the fowls can never again take the disease.

With regard to the reason of the immunity, we cannot avoid the idea that the microscopic organism which causes the disease, finds in the body of the animal a medium in which to grow, and that it alters or destroys certain substances while carrying out the activities of its own life. But when the perfect immunity is attained, one may inoculate any muscle one pleases with the more deadly organism without obtaining the slightest effect, that is, all cultivation in these muscles is now impossible; they no longer contain materials to nourish the microbion.

The question now is, whether this suppression of the possibility of any cultivation of the parasite in the muscles is limited to these parts which have undergone the protective inoculation. To decide this, a new series of strongly vaccinated fowls was once inoculated by introduction of the poison into the jugular vein, and in a second series of experiments by feeding with the infected muscles of a fowl which had died of the parasite. The result was that in both cases the fully

* 'Comptes Rendus,' xc. (1880) pp. 952-8. Cf. 'Naturforscher,' xiii (1880) pp. 247-8.

vaccinated individuals were uninjured, none of them dying; while those not vaccinated succumbed to the poison, both when this was directly introduced into the blood and when it was introduced by the alimentary canal.

Experience shows that there are individual fowls which are proof from their birth against the poison, being protected by their constitution against taking the disease. Therefore it must be assumed in their case that they are devoid of the substance which forms the nutriment of the microbion, just in the same way as the liquor of beer-yeast is absolutely unfitted to nourish the same parasite, while other microscopic organisms thrive very well in this liquid.

"The explanation to which the facts lead us," says M. Pasteur, "both with regard to the innate resistance which certain individuals manifest, and to the immunity which is induced by repeated vaccinations, appears very natural when one remembers that in general every process of cultivation alters the medium in which it takes place: the soil is altered when it comes in contact with ordinary plants; plants and animals are altered when they meet with their parasites, and our cultivating liquids are altered when they meet with Mucedineæ, Vibriones, or ferments. These modifications are both betrayed and characterized by the circumstance that fresh growth of the same species in these media is impossible or very difficult. If we sow fowls' broth with the cholera microbion and filter the liquid after three or four days to remove every trace of it, and sow the filtered liquid afresh with the parasite, this shows itself entirely incapable of undergoing the slightest development. If the liquid is entirely clear after the filtering, it preserves this clearness intact.

Must not the thought occur to us, that by the cultivation of the weakened poison in the fowl, its body is put into the position of the filtered liquid, which cannot support the microbion. The comparison may be followed out further, for if the solution is filtered while the cultivation of the microbion is in full activity—not on the fourth, but on the second day of growth—then the filtered liquid will still be in a condition to grow the microbion afresh, though less energetically than at first. We see therefore that after cultivation of the weakened microbion in the fowl's body we have not been able to exhaust its nutriment in all parts of the body. Thus that which is left behind will allow of a fresh growth, but again to a more limited extent. This is the action of the first vaccination. Subsequent inoculations will gradually remove all the material for the cultivation of the parasite. Through the action of the circulation a moment must come, at which any fresh growth in the fowl remains unfruitful. Then the disease can no longer recur, and the individual is fully vaccinated. It may be wondered that a first growth of the mitigated poison should remain inactive, before the materials for nourishing the microbion are exhausted. But we should not forget that as the microbion is a gas-needing being, it exists by no means under the same conditions in the body of the animal as in an artificial medium for growth. Here there is no obstacle to its increase. In the body, on the contrary, it is incessantly in conflict with the cells of the organs, which are in like manner beings which need gas, and are always ready to seize upon the oxygen.

But is this the only possible explanation of the phenomena? Not strictly speaking. We can account for the facts of non-recurrence if we assume that instead of removing and destroying certain substances in the body of the animals, the life of the microbion introduces certain others which are a hindrance to the further development of this microbion. The life-history of the lower organisms, and in general of all organisms, justifies such an assumption. The excreta produced by the vital processes may oppose a vital function of the same species. In certain fermentations antiseptic products are seen to arise, during and as the result of the fermentation, which put an end to the active life of the ferments and to the fermentation long even before this. A formation might take place during the cultivation of our microbion of products whose presence would strictly explain the immunity and the vaccination.

But our artificial cultivation of the parasite allows us to control this hypothesis as well. Let us prepare an artificial growth of the microbion, and after evaporating it under the influence of cold and in a vacuum, restore it to its original volume by a cultivating solution. If the extract contains what is a poison to the life of the microbion, and if this is a reason for cultivation being impossible in the filtered liquid, then the sowing in the fresh medium should prove unfruitful; but it is not so. Thus it is impossible to believe that substances appear during the life of the parasite which are able to oppose its further development. This observation confirms, on the contrary, the former theory, given above, with regard to the causes of the non-recurrence of certain infectious diseases."

A further fact in support of his views of the nature of the immunity and the vaccination was communicated by M. Pasteur to the Academy: * In well-vaccinated and healthy fowls sometimes appear, in one part or other of the body, boils, full of pus, which have caused no injury to the health of the bird. It was remarkable that these boils originated from the cholera microbion which was preserved in them as in a closed vessel, and doubtless was only unable to reproduce itself because the fowl was vaccinated. The pus could be taken from the boils and cultivated, or fresh fowls could be inoculated with it, in which it developed largely and killed them in the ordinary way. These facts remind us of the observations which M. Pasteur described in his first memoir on the behaviour of the guinea-pig with regard to inoculation with the poison of fowl-cholera.

M. Pasteur has followed up † his experiments in fowl-cholera by investigating with regard to the germ-theory the case of a patient afflicted with an intermittent eruption of boils. He found the matter formed in the cones of the boils to produce, when added to a proper cultivating liquid, numerous microscopic spherical bodies united together, generally in pairs. The same occurred with matter taken from a less advanced boil. Differential experiments showed the production of

* 'Comptes Rendus,' xc. (1880) pp. 1030-3. Cf. 'Naturforscher,' xiii. (1880) p. 218.

† Ibid., pp. 1033-44.

the bodies by this matter, and not by blood or lymph taken from other parts of the same subject, even when from the very edge of the boil. Three separate subjects were experimented on, and from each the same microscopic organism was obtained.

By injecting the cultivated growths of the organism under the skin of rabbits, &c., small and readily healed abscesses were produced in which the organism was found in a state of development. Injected into the jugular vein of guinea-pigs, the growths produced no result, a circumstance which is important as confirming other experiments which show the difficulty—due probably to its healthy activity and the absorption of oxygen by the blood-corpuscles—of propagating such organisms in blood. The disease *osteomyelitis* is also accompanied by the same growth, in the form of minute grains aggregated by twos and larger numbers.

In an ultimately fatal case of *puerperal fever*, the *lochia* were found to contain the same organism. Two days later, the blood itself was found to contain a growth of long chains of cells. After death, pus from the peritoneum, the blood of the basilic and femoral veins, and pus from the surface of the uterus and Fallopian tubes was found on cultivation to contain the germs of the long chains of cells. In the peritoneal matter occurred a vibrio, already described as "organism of the pus." In another instance, in which the mother and child both died, the boil-organism and the pus-vibrio were found in the lochia and in the milk, and the inoculation of a rabbit with the matter caused the development in it of large abscesses. In another case the blood and the synovial membrane of the knee were ultimately affected by the chain-like microphyte. In the blood of an infant which died soon after birth, was found the pyogenic vibrio. The only indications of disease found in the mother were a number of abscesses in the liver and ulcerations on the hepatic vein. The lymphatics of the uterus appear in some cases to distribute the disease-germs to the rest of the body.

Professor Lister, in his address to the Cambridge Meeting of the British Medical Association,* says: "I need hardly remark on the surpassing importance of researches such as these. No one can say but that, if the Association should meet at Cambridge again ten years hence, some one may be able to record the discovery of the appropriate vaccine for measles, scarlet fever, and other acute specific diseases in the human subject. But even should nothing more be effected than what seems to be already on the point of attainment—the means of securing poultry from death by fowl-cholera, and cattle from the terribly destructive splenic fever, it must be admitted that we have an instance of a most valuable result from the much-reviled vivisection."

**Fowl-Cholera and "Sleep Disease."**†—M. Talmy has been struck by the resemblance of the fowl-cholera to the "sleep disease" or "nelavan," which attacks the natives of the west coast of Africa. In this disease, whose symptoms may be compared with those given

* Loc. cit. † 'Comptes Rendus,' xc. (1880) pp. 1014–17.

above for the fowl-cholera, the eyelids are half closed. At certain times an urgent want of sleep is felt; later, sleep becomes continuous; the sick person has to be awakened for his meals. Sleep now takes place in the most various and uncomfortable attitudes, but in such as need no muscular effort; the body gradually becomes stretched out until death ensues quietly and without pain. The patients are sometimes affected at the same time with swellings on the neck, and these have been excised with the effect of curing the disease. The disease appears to differ from that affecting fowls, in its long duration—lasting a year or two in some cases—and in inevitably proving fatal. It is said to attack individuals who have eaten large-necked fowls or fish with swollen gills; hence these animals should be carefully studied in order to trace the connection between their condition and the disease which attacks human beings.

With reference to this subject, M. Déclat quotes * the cure of two cases of the disease by means of phenic acid, which is used so successfully in the case of other diseases due undoubtedly to septic organisms. This seems to confirm the belief in a similar origin. The phenic acid solution is injected, 100 drops at a time, and these injections are often repeated. A gradual recovery followed the operation in the two cases quoted.

**Fowl-Cholera and Anthrax.**† — In a letter to M. Dumas, M. Pasteur alludes to his experiments ‡ on the cultivation of the fowl-cholera bacterium in fowls' broth (which appear to show that in the process certain principles necessary to the life of the bacterium are removed from the liquid), and to his subsequent opinion that probably fowls vaccinated for the "cholera" would not be proof against anthrax. Numerous experiments have, however, since shown him that the effects of anthrax on a medium inoculated against fowl-cholera are slow, small in amount, and difficult to produce. Some of his experiments tend to prove that this result is shown in fowls similarly treated, which, if confirmed, shows that an immunity from anthrax can be created by means of a parasitic malady of quite a different nature.

**Etiology of Anthrax.**§—The origin and mode of propagation of this disastrous disease are considered by M. Pasteur worthy of investigation for the purpose of discovering proper means for its prevention. The works of Davaine and Delafond in France, and Pollender and Bräuel in Germany, have shown that the blood of animals which have died of the disease contains a microscopic parasite, while Koch of Breslau, in 1876, showed that the vibrionic form of the organism is capable of resolution into spores. With the support of the Minister of Agriculture, and the departmental President of the General Council of Eure-et-Loire, M. Pasteur, in 1878, instituted experiments on a small flock of sheep near Chartres in the open air.

Certain sheep were fed on lucerne, which had been sprinkled with

* 'Comptes Rendus,' xc. (1880) pp. 1088-90. † Ibid., xci. (1880) p. 315.
‡ See *ante*, p. 1010. § 'Comptes Rendus,' xci. (1880) p. 86.

artificial growths of the anthrax-bacterium, full of bacteria and germs. A small number of the sheep thus treated died, after a period of incubation of the disease of from eight to ten days, with all the symptoms of anthrax; many sheep escaped with no other hurt than becoming decidedly unwell. The mortality increased when to the food treated as above were added rough objects, such as points of dried thistle-leaves, and especially the spines of barley-ears cut into minute fragments. The appearances found in animals which die under these conditions are exactly those of such as have died spontaneously of the disease, and show that its effects commence in the mouth or the pharynx. From these experiments it seems that the anthrax-poisoned animals of the Eure-et-Loire district die under the effects of spores taken in with their food.

In spite of the opinion of M. Davaine, that an animal which has died of anthrax cannot communicate the disease after putrefaction, and that of M. Colin, that earth and water containing anthrax-infected matters do not transmit the infection, it may be shown that though during putrefaction the bacterium dies, its spores survive to propagate infection. The difficulty of proving this fact is great, for the relative amount of the organism dispersed among the particles of soil is almost infinitesimal, and, when it has reached the soil, it there meets with so many antagonistic agencies, in the form of other germs which compete with it for existence, that it requires very careful handling (e. g. cultivation in air or vacuum or with other changes of medium and temperature) to bring the particular species to maturity from the soil examined, even though it is there already.

It is stated by the slaughterers that there is no danger in handling the bodies of the diseased animals when putrefaction has begun, and that there is no cause for apprehension when so doing after the animal has become cold; and MM. Pasteur and Joubert have shown that when placed in a vacuum or in an atmosphere of carbonic acid, the bacterium dies and breaks up into granules, while its spores live. Now it appears probable that the bacteria of a diseased animal which has been buried escape in abundance into the surrounding earth in the blood which usually issues at death by the nostrils and the mouth, and in the urine, and at a later stage in the liquids expelled by gaseous inflation of the body; probably not even in the latter case has decomposition set in and destroyed the parasite. A proof of this view is found in the fact that infected blood added to earth sprinkled with yeast liquid or urine, and kept at the temperature which probably exists around a decomposing animal, shows that a multiplication of its bacteria and their resolution into germs takes place. A still more practical proof is furnished by the case of a diseased sheep which was buried as an experiment; ten months afterwards the earth of the grave furnished germs of the bacterium capable of causing the death of fowls inoculated with them, and did the same four months later. The graves of some diseased cows furnished anthrax-material during and after an interval of two years since burial. Lastly, the bacteria have been detected in the earth above graves over which cultivation has been carried on, and at those points of the field alone.

The explanation of how the bacteria reach the surface is to be found in the operations of the earth-worms which bring to the surface much of the subjacent earth; in their casts, as in the earthy contents of their digestive canals, the germs are found. The contents of these cylinders of soil when they are broken up by rain and then scattered in the form of dust become distributed over the low plants of the pasturages, with the same fatal effects to the animals browsing there as were shown above in the experiments with infected fodder. The dangerous state of the soil in this case suggests the use of cremation to destroy the germs.

The soils most likely to be proof against the transmission of the disease would appear to be poor, sandy, or calcareous, not damp ones, which would be thus unfitted for worms. These conditions are found in the *Savarts* of Champagne, where a poor, shallow soil rests directly on chalk, and in parts of Aveyron, where the soil is schistous and granitic, and in these places anthrax is unknown.

**Anthrax—Its Spread and Prevention.*** — M. Pasteur's views as to the cause of the spread of this disease in certain countries, viz. by the liberation of the bacteria from the decomposed bodies of animals, and their subsequent dispersion by the agency of earth-worms, cultivation of the soil, &c., are supported by the circumstances connected with an outbreak of the disease in a village in the department of the Jura.

Here three cows which had died of the disease were buried at a depth of 2· metres. At different times within the ensuing two years the rich earth and the worm-casts above the graves were examined, and in all cases were found to contain germs of the *Bacillus anthracis*, while earth taken from a few metres' distance contained none.

To further show the transmissibility of the germs, a pen was made over one of the graves, and four sheep were placed in it; and in a second one, a few metres above the first, were placed four more sheep. After a week one of the sheep in the former pen died, and the cause was found to be the *Bacillus*. The sheep in the second pen remained quite well. The origin of the disease was evidently therefore in the earth infected by the dead cow.

Another important question relating to this disease is the possibility or impossibility of preventing its recurrence. M. Bouley gives an account † of experiments made by M. Toussaint on twenty sheep by inoculating them with a liquid intended to preserve them from anthrax. Of the twenty animals, four died of the disease. To show the immunity conferred by inoculation, two of the surviving sixteen sheep were again inoculated with a very active anthrax solution, without experiencing any ill effects, while a rabbit treated with the same fluid died.

To make this discovery practically useful it will be necessary to obtain virus of such a strength that it will act with sufficient vigour without destroying the animals subjected to it. M. Chauveau states

* 'Comptes Rendus,' xci. (1880) p. 455. † Ibid., p. 457.

that the Algerian breeds of sheep are peculiarly refractory to the disease, only exhibiting when inoculated the minor signs of its action, viz. rise of temperature, glandular swellings, and low spirits. The immunity is carried further with lambs born of dams inoculated in the last stage of gestation, for inoculation is absolutely without result in their case.

One operation therefore effects two results, the immunity of the mother and that of the offspring at the same time.

M. Pasteur,* having determined to test independently some similar results obtained by M. Louvrier, instituted experiments on cows to ascertain the effect of inoculation with the bacteria which cause the disease. On inoculation of two cows, each with five drops of a solution of these organisms behind the right shoulder, swellings appeared on both. In the one the swelling disappeared—no rise of temperature occurring—by the fifth day after the operation. In the other, after two days, the swelling extended to the belly, the cow became very ill, the temperature rose from 38·8° to 41·5° C. M. Louvrier then applied his method of recovery, which consists of warming by friction, and by subcutaneous injection of terebenthine, and of covering all the body except the head with hay soaked in warm vinegar. By the fourth day the temperature had fallen to 39·7°, but the swelling under the stomach was very large, and the lymphatic glands of the thigh hard and painful; then the recovery became pronounced, by the gradual fall of temperature and diminution of the swelling. Subsequent inoculation of the first cow produced no effect. Another inoculated individual passed safely through the stages of the disease above mentioned without the aid of M. Louvrier's palliative measures. On repeating the inoculation upon the two cows which had passed through the disease with much pain, the only result observed was a slight swelling. A third inoculation produced no effect at all.

Thus the disease once passed through cannot recur, as has been already proved for French sheep. A further experiment shows that the method of M. Louvrier is not a specific cure for the disease, for of four inoculated cows, two of which were treated by him and two not, one of each category died, while the two survivors showed no ill effects when re-inoculated on the side opposite to that of the first operation.

The relative insusceptibility to the disease of the Algerian breeds of sheep is explained by M. Pasteur as caused by a vital resistance of the constitution, not—as held by M. Chauveau—by the presence in the animals of substances obnoxious to the bacterium; for with fowls, merely cooling them brings out the charbon. M. Chauveau's facts as to the Algerian sheep and the charbon harmonize well with M. Pasteur's explanation.

**Immunity from Anthrax obtained by Inoculation.**†—M. Toussaint's long experience has led him to believe that the bacterium of anthrax is not completely at its ease when developing in animals, for

* 'Comptes Rendus,' xci. (1880) p. 531. † Ibid., p. 135.

it multiplies there by division only, not by spores. Some animals are more readily affected by it than others (e.g. the pig), and others in youth rather than in old age (e.g. the dog, horse, and ass). He has been able to prevent its development in young dogs and in sheep by a method of inoculation with spores or with the bacterium in its fission-stage (*bacillus*).

Four puppies were thus inoculated, and five were not. The first batch resisted successfully four successive inoculations, while the non-vaccinated puppies succumbed to the first inoculation in from two to four days, showing great œdema of neighbouring parts. The first batch developed slight fever, and in two cases slight œdema; the other inoculations produced no effect on them.

Of eleven sheep of the Lauragnais race, which is very susceptible to the anthrax, five which were once inoculated with the poison died. The remaining six were inoculated by the preventive method, and one died from the effects of a subsequent inoculation out of two thus tested. The other five were re-vaccinated, and in a month's time were found to show no signs even of illness when inoculated in various ways.

M. Toussaint has also performed experiments of injecting into the blood of healthy sheep blood taken from an animal affected with splenic fever, but deprived of the *Bacillus anthracis*. Taking blood from a sheep just on the point of death, when the bacillus has presumably produced all its possible effect upon the vital fluid, M. Toussaint proceeds to deprive it of the living bacillus in either of two ways—by filtration, or by destroying the vitality of the organism. The former he effects by mixing the blood with three or four parts of water, and then passing it through about twelve layers of ordinary filter-paper. The bacillus, in consequence of its large dimensions, is entirely retained by this form of filter, as is proved by the fact that the filtrate no longer gives rise to the organism in a cultivating liquid or in a living animal. Nevertheless, if injected in considerable quantity into the circulation of a healthy sheep, it produces a true vaccinating influence; that is to say, secures immunity from splenic fever. But (what is further extremely interesting), in order that this change in the constitution of the sheep may be brought about, the lapse of a certain time is essential. If a vaccinated sheep be inoculated with anthrax within a few days of the operation, it will die of splenic fever; but if from twelve to fifteen days be allowed to elapse, complete immunity is found to have been produced.

Similar results followed from the injection of anthrax blood treated by M. Toussaint's other method, which consists of maintaining it for a considerable time at a temperature of 55° C., which has the effect of killing the bacillus; after which half per cent. of carbolic acid is added, to prevent putrefaction of the liquid. The blood treated in this way having been proved to be free from living bacilli by negative results of an experiment upon a rodent, about four c. c. are injected into the venous system of a sheep, with the effect of producing the same protective influence against splenic fever as is ensured by the filtered blood. These experiments are still in progress, but M. Toussaint informs Professor Lister that he has already ascertained the existence of immunity against anthrax for 3½ months in both sheep and dogs treated in this way.*

**Identity of Bacillus anthracis and Hay-Bacillus.**†—This has been investigated by Dr. H. Buchner of Munich, of whose observations Professor Lister gives the following account:—

"It is well known that the *Bacillus anthracis* is morphologically identical with an organism frequently met with in infusion of hay, which may be termed hay-bacillus. Such being the case, it occurred to Dr. Buchner that they might be merely one and the same organism modified by circumstances. For my own part, I am quite prepared to hear of such modifying influence being exerted upon bacteria, having made the observation several years ago that, when the *Bacterium lactis* had been cultivated for some time in unboiled urine, it proved but a feeble lactic ferment when introduced again into milk. Its power of producing the lactic fermentation had been impaired by residence in the new medium. In the case before us, indeed, the physiological difference between the two organisms seems, at first sight, so great, as to forbid the idea of anything other than a specific difference. The *Bacillus anthracis* refuses to grow in hay-infusion in which the hay-bacillus thrives with the utmost luxuriance; and conversely, the hay-bacillus is utterly incapable of growing in the blood of a living animal, whether introduced in small or in large quantities. The hay-bacillus is remarkable for its power of resistance to high temperatures, which is not the case with the *Bacillus anthracis*. The latter is destroyed by a very slight acidity of the liquid of cultivation, or by any considerable degree of alkalinity, whereas the former survives under such conditions. Both will grow in diluted extract of meat, but their mode of growth differs greatly. The hay-bacillus multiplies rapidly, and forms a dry and wrinkled skin upon the surface, while the *Bacillus anthracis* produces a delicate cloud at the bottom of the vessel, increasing slowly.

Nothing daunted by these apparently essential differences, Dr. Buchner has laboured with indomitable perseverance, by means of experiments carried on in Professor Nägeli's laboratory, to solve the double problem of changing the *Bacillus anthracis* into hay-bacillus, and the converse. Having devised an ingenious apparatus by which a large reservoir of pure cultivating liquid was placed in communication with a cultivating vessel, so that any cultivation could be drawn off by simply turning a stop-cock, and further cultivating liquid supplied to the organisms remaining in the vessel by a mere inclination of the apparatus, Buchner proceeded to cultivate the isolated *Bacillus anthracis* in extract of meat for several hundred successive generations. As an early result of these experiments, he found that the bacillus lost its power of producing disease in an animal inoculated with it. Up to this point he is confirmed by Dr. Greenfield,‡

* Cf. 'Brit. Med. Journ.,' loc. cit.

† SB. k. Bay. Akad. Wiss.,' 1880, pp. 368–413, and Prof. Lister's Address, loc. cit.

‡ See this Journal, *ante*, p. 838.

who has found that, when the *Bacillus anthracis* is cultivated in aqueous humour, after about six generations it loses its infective property. Then as Buchner's experiments proceeded, the appearance of the growing organism was found to undergo gradual modification. Instead of the cloud at the bottom of the vessel, a scum began to make its appearance—at first greasy-looking and easily broken up—constituting, so far as appearances went, an intermediate form between the two organisms; and in course of time the scum became drier and firmer, and at length the modified *Bacillus anthracis* was found to be capable of growing in an acid hay-infusion, and to present in every respect the characters of the hay-bacillus.

The converse feat of changing the hay-bacillus into the *Bacillus anthracis* proved very much more difficult. A great number of ingenious devices were adopted by Buchner, who was, nevertheless, continually baffled, till at last he attained success in the following manner. Having obtained the blood of a healthy animal under antiseptic precautions, and defibrinated it also antiseptically, and having arranged his apparatus so that the pure defibrinated blood, which was to be the cultivating medium, should be kept in constant movement, so as to continually break up the scum, and also keep the red corpuscles in perpetual motion so as to convey oxygen to all parts of the liquid—in this way imitating, to a certain extent, the conditions of growth of the *Bacillus anthracis* outside the animal body, within which the hay-bacillus could not be got by any means to develop—he proceeded to cultivate through numerous successive generations. A transitional form soon made its appearance; but the change advanced only to a limited degree, so that further progress by this method became hopeless. The modified form hitherto obtained failed entirely to grow when injected into the blood of an animal. On the contrary, it was in a short time completely eliminated from the system, just like the ordinary hay-bacillus. It had, however, been observed by Buchner that spores had never been formed by the bacillus growing in the defibrinated blood; and it occurred to him that, perhaps, if it were transferred to extract of meat, and induced to form spores there, the modified organism might yet grow in the blood of a living animal. The carrying out of this idea was crowned with success; and, both in the mouse and in the rabbit, Buchner succeeded by injecting various different quantities containing the organism in different animals. When large quantities were introduced, the animals died rapidly from the merely chemical toxic effects of the injected liquid; but in some instances, after the period for these primary effects had passed, a fatal disease supervened—attended, as in anthrax, with great swelling of the spleen, the blood of which was found peopled as in that affection with newly formed bacilli; and the spleens affected in this way were found to communicate anthrax to healthy animals, just like those of animals which had died of ordinary splenic fever.

Supposing these results to be trustworthy—and the record of them bears all the stamp of authenticity—I need scarcely point out their transcendent importance as bearing upon the origin of infective diseases, and their modifications as exhibited in epidemics."

**Bacteria in Ear-disease, &c.***—M. B. Loewenberg has discovered in abscesses of the auditory meatus the same microscopic organism (*micrococcus*) found by M. Pasteur in surface-boils. He regards the multiplication of boils on any individuals to be due to what he calls "auto-contagion," or the spread of matter from an open boil over other parts of the body, conveying its microbia with it, to deposit them in other follicles of the skin, and there set up fresh irritation; and, this granted, the spread of the affection to other individuals is seen to be a probable occurrence.

The treatment of this disease of the ear is that of cutting through the abscess and then bathing the place with solutions of thymic or boric acid, or sprinkling it with the latter acid finely powdered. In the case of *general* furunculosis, lotions of boric acid solution applied to the whole body have been found to prevent the formation of new boils in the single instance in which the experiment was made. With regard to other diseases of the ear, the *micrococcus* is found in great abundance in cases of otorrhœa where the ear has not been properly cleansed, especially where a fetid condition has arisen. In the employment of emollients, such as poultices, in these cases, the debris cast off is found to be surrounded by a coat of the *micrococcus;* boils are often noticed after a long-continued use of these applications, and so they may perhaps act deleteriously by developing the parasite.

**"Hysterophymes" of Starch and Fat.†**—H. Karsten discusses the chemical composition of *Torula*, *Bacteria*, *Vibriones*, and the other incitors of putrefaction and fermentation, which he does not regard as specific organisms, but as pathological forms of cells, terming them "Amyloid- und Fett-hysterophymen." Their formation depends, according to him, on the presence of a definite organic substance, soluble in water, together with phosphoric acid and its salts, and of a deficiency of nutrient salts in the superficial layer. The addition of sugar to a butyric nutrient fluid causes the *Vibriones*, *Bacteria*, *Micrococci*, and *Dicocci*, to develop into *Torula*-cells.

**Carpozyma, the Ferment of Wine.‡**—In the recently published second volume of his great work on viticulture, M. Ladrey describes the various ferments associated with the fermentation of beer and wine, enumerating the various species of *Saccharomyces* established by Reess.

In addition to these, he describes another alcoholic ferment which, according to Engel, does not belong to that genus, but is a *Protomyces* without mycelium, and is called by him *Carpozyma*. Engel affirms that all fermentations of the must of fruits are caused by the growth of a ferment, the mature cells of which are ellipsoidal in form, about 6 $\mu$ in length and 3 $\mu$ in breadth, the two ends having each a small protuberance or apiculus, which gives to the whole the form of a citron. When vegetating in a fermenting fluid, the young cells

* 'Comptes Rendus,' xci. (1880) p. 555.

† 'Zeitschr. Allgem. oesterr. Apotheker-Verein,' 1880. See 'Bot. Centralbl.,' i. (1880) p. 596.

‡ Ladrey, C., 'Traité de viticulture et d'oenologie,' 2me ed., tome ii. Paris, 1880. See 'Bot. Centralbl.,' i. (1880) p. 718.

always appear at these small protuberances, and nowhere else. Most commonly they have at first the form of a small spherule; and not till one of them has attained one-half its full size does the second appear at the opposite end; much less frequently the two appear simultaneously at opposite ends of the mother-cell. Reess did not succeed in inducing this ferment to produce spores. Engel was more fortunate, and discovered that the mode of fructification was very different from that of *Saccharomyces*, closely resembling that of *Protomyces.*

Engel gives the following diagnosis:—*Carpozyma* n. gen.—Vegetative cells isolated, producing buds at their poles, which soon become detached; theca spherical, clothed with a perithecium, and hibernating; spores numerous, developing very slowly. Solitary species, *C. apiculatum* Engel.—Vegetative cells ellipsoidal, terminated at their poles by two projecting mamillæ, which give them a resemblance to a citron.

### Lichenes.

**Morphology of Lichens: Endophlœal Species of Polyblastia; Epiphora; Magmopsis.***—A. Minks is carrying out a series of minute morphological observations to assist in determining the yet unsettled points in the structure of lichens.

1. In his monograph of the Scandinavian *Polyblastiæ*, T. Fries separates from the genus on the one hand *P. discrepans* Lehm. and *Verrucaria subdiscrepans* Nyl., from the want of one layer, and from their parasitic habits on other crustaceous lichens, and unites them with the Endococci among the Pyrenomycetes; on the other hand, the bark-dwellers *P. lactea* Mass., *P. sericea* Mass., *P. fallaciosa* Stizb., and *Verrucaria subcœrulescens* Nyl., from the want of one layer and of the gonidia. Minks asserts the latter to be true lichens, as shown by the presence of microgonidia in the paraphyses, asci, and spores, and has subjected the structure again to careful examination.

The hyphema of crustaceous lichens is the forerunner of the hyphæ in their various forms, and the matrix of the hyphæ which envelope the already formed groups of gonidia. The species of *Polyblastia* already named possess, in addition to the gonangia as a form of acroblastesis, a mesoblastesis as respects the formation of gonidema or gonothallium. This form of mesoblastesis occurs in the midst of the course of the short-celled secondary hyphæ, and begins with the division of a smaller number of its cells in the common axis of the hyphæ, producing finally a pseudo-parenchymatous structure, in which the development of the gonidia takes place from the microgonidia present in each cell. The same process takes place also in the cells of the hyphema, in the same way as in the hyphema of *Nostoc* and *Leptogium.*

The forms referred to are united by the author into one species, without exactly defining its limits. As to its position, he would unite the cortical *Polyblastiæ* with the forms included under *Blastodesmia*, *Acrocordia*, and *Pyrenula* Körb., rather than with the genera

* 'Flora,' lxiii. (1880) pp. 129, 195.

*Arthopyrenia* and *Microthelia*, into which the genus *Pyrenula* Tuck. must be separated.

2. With respect to the genus of epiphytal lichens *Epiphora*, established by Nylander, Minks states that *E. encaustica* is a true lichen, which, however, in consequence of unfavourable vital conditions, is unable to attain full development, and does not therefore possess the characters of a true species, still less of a distinct genus.

3. The new genus *Magmopsis* was considered by its author Nylander as the representative of the peridium-type among the Byssaceæ. A careful study has, according to Minks, established the fact that, in the supposed peculiar thallus of *Magmopsis*, Nylander had under his eyes a mixture of three distinct layers. The altogether lecideine apothecia belong to *Catillaria athallina* Hepp., or a nearly allied species. The thallus and the apothecia of this are overgrown by two other lichen layers, still in an early stage of development. The apparent peridium-type arose from the overgrowth of a hypothallus bearing densely crowded gonocysts.

**Application of Pringsheim's Researches on Chlorophyll to the Life of the Lichen.***—Mr. G. Murray, referring to the suggestion of Dr. Vines in regard to Pringsheim's researches,† that by the aid of an artificial chlorophyll screen the protoplasm of fungi might be excited to the decomposition of carbonic acid, and to the formation of starch from carbonic acid and water, contends that this experiment is proceeding *naturally* in Lichens. In these organisms we have the fungal tissues in the body of the thallus, and the chlorophyll screen in the gonidial layer; that is, the chlorophyll is in one system of cells, and the protoplasm, apparently affected by it, in another, which is in contact. Light traversing the chlorophyll-containing gonidial layer excites in the fungal tissues the decomposition of carbonic acid. In evidence he adduces the plentiful occurrence of starch, or rather lichenin—a substance of the same chemical composition as starch ($C_6H_{10}O_5$) and formed from it by the action of the free acids of the plant.

This process, he considers, tends to explain the nature of the consortism of the fungal and algal elements in the autonomous Lichen, and thus to support the well-known views of Schwendener.

## Algæ.

**Agardh's 'Morphologia Floridearum.'**—Professor Agardh republishes this work (in Latin, with 301 pp.) uniform with and forming vol. iii. part 2 of his 'Species, Genera et Ordines Algarum,' in 8vo. Unfortunately the reader is referred to the 4to edition for the plates which illustrate the subject, they not having been reproduced with the text.

**Oxyglossum, a new Genus of Laminariaceæ.‡**—Under this name Professor J. L. Areschoug proposes to establish a new genus

* 'Journ. Linn. Soc. Lond.' (Bot.), xviii. (1880) pp. 147–8.

† See this Journal, *ante*, pp. 117 and 480.

‡ 'Bot. Notiser,' 1880, pp. 96–98. See 'Bot. Centralbl.,' i. (1880) p. 1154.

founded on the species hitherto described by Suringar * and himself as *Laminaria japonica*, and previously by Thunberg as *Fucus saccharinus*. The following is his diagnosis of the genus:—Radix fibrosa; stipes complanatus, evanescens in laminam e basi acute ovata et firmiore, lineari-lanceolatam, fascia percursam, in apicem juniorem integrum et non dissolvendum longissime productam. Fructificatio in parte inferiore et crassiore (?).

**New Endophytic Alga.**†—Under the name *Entocladia Wittrockii*, N. Wille describes a new Alga endophytic or parasitic on two species of *Ectocarpus*, *E. siliculosus*, and *E. firmus*, in a fiord in the neighbourhood of Christiania. It forms unbranched or slightly branched rows of cells in the interior of the cell-wall of the host. Its cells contain large starch-grains and parietal chlorophyll. All the cells may form in succession four, eight, or perhaps a larger number of zoospores, which escape through a circular opening in the cell-wall.

**New Genus of Oscillatorieæ.**‡—In "Contributions to the Alga flora of Würtemberg," Dr. O. Kirchner describes under the name *Clastidium*, a new genus of Oscillatorieæ belonging to the section Chamæsiphoneæ (Borzi), with the following characters:—Filaments short, unbranched, without sheath, firmly fixed at the base, provided at the apex with a thin, erect, unsegmented bristle; cells scarcely distinguishable in the young state; afterwards cylindrical, finally spherical; reproduction by isolated gonidia resulting from the entire filament breaking up into spherical cells.

The only species, *C. setigerum*, grows attached to filaments of *Cladophora*, which it completely covers; the bristle is delicate, about 0·05 mm. long; the cell-contents homogeneous, pale blue-green; the entire filament, excluding the bristle, when mature, 0·028 to 0·038 mm. long, 0·0025 to 0·004 mm. thick.

*Clastidium* is the only known genus of Oscillatorieæ provided with a bristle, which is formed at an early period, and may be compared to that of *Coleochæte* or *Bulbochæte*; no hormogonia have been observed.

**Change of Colour in Oscillatorieæ.**§—P. Richter states that too much value must not be placed on colour as a distinguishing character of the species belonging to the genera *Oscillatoria* and *Phormidium*. Cohn considers the bright green colour of the Phycochromaceæ to be due to a mixture of green chlorophyll and blue phycocyan. According to Richter, a deficiency of water is favourable to the formation of phycocyan, and hence to a blue-green colour, in consequence of the solubility of phycocyan in water. The same species will exhibit different colours, according to the quantity of water in which it grows, and other conditions.

* 'Algæ Japonicæ,' p. 21.

† 'Christiania Vidensk. Forhandl.,' 1880. See 'Bot. Centralbl.,' i. (1880) p. 579.

‡ 'Jahreshefte Ver. für vaterl. Naturk. Württemberg,' xxxvi. (1880) p. 155.

§ 'Bot. Centralbl.,' i. (1880) p. 605–7.

**Cell-division in Conferva and Œdogonium.***—N. Wille has observed the mode of cell-division in a large newly discovered variety of *Conferva amœna* which he calls var. *norvegica.* The cell-wall appears to be composed of pointed H-shaped pieces, a smaller and a larger one always alternating, the latter enclosing the margins of the former like the lid of a box. The whole row is surrounded without and within by a dense substance which binds it together. The division of the cells is preceded by the formation of a watery layer, which may be termed the "lengthening-layer," in the interior of the dense layer which lies on the inner side of the cell. The further development of this lengthening-layer causes the older pieces of cell-wall to become separated from one another. At this period the nucleus divides, becoming first of all constricted in the middle, and then breaking up into two parts, which at once begin to separate from one another, parietal protoplasm at the same time collecting between them. The new septum then develops from the lengthening-layer in the form of a circular ridge inside the cell, the central part being perhaps formed at the time, and divides it into two halves. When fully developed cells open, the cell-wall breaks up into H-shaped sharp-pointed pieces; but when cells open while in the act of division, the ends of these pieces are united by a membrane, since in this case the line of dissociation does not pass through the innermost denser layer.

*Conferva flaccosa*, Ag. β *Novæ Semliæ* can multiply by the cells losing their connection with one another.

Cell-division in *Œdogonium* is thus described by the same writer. The ring of cellulose is here the "lengthening-layer," and is formed in the same way as the corresponding layer in *Conferva;* but its subsequent development differs in the greater firmness of the cell-wall. In occasional abnormal instances the development resembles that in *Conferva.* While, in *Conferva*, the lengthening layer and the septum are closely united with one another, in *Œdogonium* they are quite distinct. In the latter the septum is formed simultaneously in a disk of parietal protoplasm, which is no doubt produced by the activity of the nucleus, this latter appearing to divide like that of *Conferva.* The ring of cellulose expands to a new piece of cell-wall, by which means the young septum is raised up by the pressure in the lower daughter-cell, uniting them in its growth with the wall of the mother-cell.

**Incrusted Filaments of Conferva.**†—Professor Hanstein has observed, in a ditch at Godesberg, which receives the very warm water of a steam engine, as well as water impregnated with iron, conferva-filaments enclosed in a thicker or thinner, continuous or interrupted, ochre-coloured envelope. The filaments were stiff bristles or knotty moniliform threads. The interrupted envelopes Hanstein believes to have been originally continuous, but to have been ruptured and separated by subsequent extension of the filaments. Both the girdles and

* 'Christiania Vidensk. Forhandl.,' 1880. See 'Bot. Centralbl.,' i. (1880) p. 579.

† 'SB. niederrhein. Ges. Bonn,' v. (1878), p. 78. See 'Hedwigia,' xix. (1880) p. 118.

the continuous tubes are always enclosed by an evident membrane, and the deposit always consists of a number of concentric layers, which are again separated by membranous division-walls. Isolated streaks or warts indicate the commencement of the deposit. On treatment with potassium ferrocyanide, with addition of hydrochloric acid, the iron is dissolved, and Prussian blue formed. The deposits first appear as minute dots between the inner and outer membranes, which soon unite; or the formation begins between the layers of the septa of two cells, forces itself outwards, and spreads in the form of a sheath in both directions of the superficies of the cell, raising up the outermost layer. The formation of several concentric layers may be the result of a repeated raising-up of successive layers of cell-wall.

Kützing has described these incrusted confervæ as *Psichohormium* (according to Hanstein *Psichormium*), but Hanstein does not consider the genus one that can be retained, and proposes to combine the species *Psichormium globuliferum*, *distans*, *approximatum*, *inæquale*, and *fuscescens* under the name *Conferva martialis*, until a more full investigation has been made of their mode of reproduction. Hanstein states that propagation has been effected by disintegration of the cells. Besides the iron hydrate there is also abundance of calcium carbonate lying loose on the surface of the filaments or between them, which, however, does not form an organic envelope, and is similar to that which occurs in *Œdogonium*; it is only attached externally. Kützing's figures of *P. antliare*, *cinereum*, *pubescens*, &c., appear to represent such incrustations.

Hanstein explains the phenomenon by supposing that these confervæ, when in active growth and greedy for carbonic acid, take up the iron dissolved by the carbonic acid in the water, deprive the carbonate of its carbonic acid, and deposit beneath its outermost layer of cell-wall the iron which has been oxidized by the nascent oxygen, while the calcium carbonate, deprived of one atom of carbonic acid, usually remains external, but sometimes in the internal spaces.

**Germination of the Zoospores of Œdogonium.***—Wille confirms in all essential points Poulsen's description, adding a few new observations. The ring is formed at the apex of the cells, and is drawn out upwards in a longitudinal direction. The red eye-spot can be made out almost until the first division takes place. A large number of the germinating plants do not multiply by division, but again form zoospores, which separate and have a long, extended, but unbranched or only slightly branched root-portion. Those which divide are either firmly seated or have a much-branched attachment-disk, which is formed when the growing root-portion meets with an impediment by which growth in length is prevented. The parietal protoplasm then continues in an active state, causing a lateral expansion of the radicular extremity, and frequently forming new branches, although growth usually ceases. The formation of cellulose appears to be proportionate to the mass of the parietal protoplasm.

* 'Christiania Vidensk. Forhandl.,' 1880. See 'Bot. Centralbl.,' i. (1880) p. 581.

**Codiolum gregarium, A. Br.***—Mr. E. M. Holmes records the recent identification of this Alga from a British locality by Dr. Bornet, it having been discovered at Teignmouth in 1855 by the Rev. R. Creswell, one of the few British algologists who have paid attention to the minute algæ growing near high-water mark, whereby he has discovered many species overlooked by others.

It forms a scattered velvety growth of a dark-green colour on the vertical surface of the blocks of sandstone and Devonian limestone forming the sea-wall, where it is liable to be wetted by the spray at high tide only, unless the sea be rough, in which case the surf dashes over it. Mr. Creswell has found it throughout the winter, year after year, in the same place, presenting the same appearance to the naked eye and the same characters under the Microscope. In June he has found full-grown specimens in a spot where the plant is within reach of every tide.

Mr. Holmes states his reasons for considering it highly probable that the "hypnospores" of Braun—the globose cells which he believed to play the rôle of resting-spores and to preserve the plant during the winter and spring months—are in fact only the earliest stage of growth of *Hormotrichum flaccum*.

**Algæ from the Amazons.**†—Professor G. Dickie gives a list of the Algæ collected by Professor J. W. H. Trail during explorations on the Amazons and branches.

Of the total of 102 species and varieties (excluding Diatomaceæ) the following are new :—

Batrachospermaceæ, *Thorea Traili.* Confervaceæ, *Rhizoclonium spongiosum*, *Glœotila nigrescens*, and *G. aurea.* Protococcaceæ, *Limnodictyon obscurum.* Nostochaceæ, *Anabæna scabra*, *Cylindrospermum cæruleum*, and *C. janthinum.* Oscillariaceæ, *Inactis obscura.* Chroococcaceæ, *Microcystis cærulea* and *M. lobata.*

Of the Diatomaceæ the names of 188 species and varieties from different localities are given, but this includes a number of duplicate species found in more than one of the localities enumerated.

**Fossil Diatoms.**‡—The Academy of Genoa has published a paper by Count Castracane on the importance of diatoms in the formation of the earth's crust. Owing to the indestructible nature of their test, the author believes that fossil diatoms enable him to demonstrate that in the vegetable kingdom "the fixity of species is a constant law."

**Dimystax Perrieri, new Ciliated Organism containing Chlorophyll.**§—Van Tieghem describes under this name an organism communicated by M. Perrier, and found by him in sea-water from Roscoff, containing Algæ and lower animals, and again in a small laboratory aquarium in the museum.

It consists of a tremulous gelatinous mass of a pure green colour and sharply limited form, spherical or oval, somewhat more than a

* 'Journ. Linn. Soc.' (Bot.), xviii. (1880) pp. 132–5.
† Ibid., pp. 123–32.
‡ 'Rev. Sci. Nat.,' ii. (1880) p. 250.
§ 'Bull. Soc. Bot. France,' xxvii. (1880) pp. 130–2.

centimetre in diameter, and fixed by a point of its periphery to some large marine algal. From a distance it has the appearance of a *Nostoc*. Exposed to solar light, it disengages oxygen, and the green colouring substance is therefore chlorophyll.

More closely examined it is seen that the mass is composed of a colourless jelly, studded with isolated green points visible to the naked eye, and sufficiently numerous to give the characteristic green colour to the whole body. It is therefore not a *Nostoc*. If some of the green points are removed from the gelatinous mass, they are found, when in a sufficiently advanced stage of development, to have a remarkable constitution.

Each of the small green bodies is nearly spherical, and measures from 0·3 to 0·4 mm. in diameter. It is composed of very finely granular and rather dark protoplasm, uniformly impregnated throughout with amorphous chlorophyll. Neither nucleus, vacuoles, nor red eye-spot can be detected, and the membrane which envelops it is very delicate. At one spot which may be termed the pole, the cell bears a tuft of vibratile cilia, attached side by side to adjacent points, and endowed with independent motion. At two diametrically opposite points of the equator is a small indentation in the green matter through which passes a strongly refractive homogeneous protoplasmic band which traverses the membrane, bends towards the pole in close contact with the inferior hemisphere, and divides at the same time at its external border into a delicate fringe composed also of vibratile cilia. Since these cilia coalesce at their base, they are not capable of independent movement. The motion is like a wave which is transmitted gradually from the outermost to the innermost cilium. In their nature and disposition these lateral cilia therefore differ considerably from those which compose the polar tuft. At this phase of development there are no cilia either at the opposite pole or at any other point of the surface of the green grains.

Notwithstanding the movements of these three tufts of cilia, which are often rapid, the entire body is in general immobile. Its centre of gravity is so placed that, in a position of equilibrium on the slide, all three groups of cilia are visible to the eye.

At a more advanced stage, the polar tuft first of all disappears gradually, losing its cilia one by one, which may be found detached in the surrounding jelly, the pole finally becoming completely bare. Next, the two lateral tufts also disappear, apparently by becoming absorbed in the general protoplasm, this being certainly the case with the band which connects them. A membrane, henceforth continuous and smooth at all points, with very sharp outline, now clothes the protoplasmic body, which has changed neither in appearance nor in size, two slight depressions at the sides still indicating the position of the lateral tufts of hairs.

Subsequently a fission takes place in the mass following the equatorial plane, and dividing it into two halves, each half then dividing again by a division at right angles to the first; and this process continues until a family of sixteen rounded cells are formed, surrounded by the primitive membrane. The division and multiplication of cells therefore takes place as in *Euglena*, at what may be termed the period of encystment, i. e. during the phase of immobility, when the body is entirely destitute of cilia.

In the next stage, each of the new cells increases in size, separates gradually from its sister-cells, becomes clothed with a delicate cell-wall, and finally entirely covered with vibratile cilia inserted independently side by side, and uniformly clothing the whole of the surface. It next begins to move about, and at the same time secretes abundance of a gelatinous substance. The cilia then gradually fall off in proportion as the body grows in acquiring its ultimate dimensions. Only the single polar tuft of hairs now remains. Beneath this bare surface, at two diametrically opposite points of the equator, a band of bright homogenous protoplasm now makes its appearance, which develops on each side into a fringe of hairs towards the pole. Thus we arrive at the original point of departure.

At no period of development can the presence of cellulose be determined in the membrane, nor of starch in the protoplasm, otherwise the process of gelatinization proceeds as in the Nostochineæ and Bacteriaceæ.

Whether this organism ought properly to be considered as belonging to the animal or to the vegetable kingdom is, M. Van Tieghem considers, doubtful, and he adds " in the present state of science this question, to which formerly so much importance was attached, seems to me devoid of interest."

The name *Dimystax* (*Perrieri*) is proposed, to indicate the secondary tufts of cilia developed after the first tuft has almost completely disappeared.

---

## MICROSCOPY, &c.

**Permanent Microscopical Preparations of Amphibian Blood.***— Mr. S. H. Gage says that the very excellent method of drying the corpuscles of mammalian blood on the slide is not applicable to the much more bulky corpuscles of Amphibia. The corpuscles of the latter are sure to be distorted and seamed in drying, hence various methods of preserving the corpuscles moist have been tried with varying success. The following very great modification of the method proposed by Ranvier in his treatise on histology † has been in use for some time in the Anatomical Laboratory of Cornell University, and has given uniformly excellent results. Preparations made three years ago are quite as good as at first.

Three or four drops of fresh blood are allowed to fall into 10 cc. of normal salt solution (common salt 750 milligrams, water 100 cc.), preferably contained in a high narrow vessel like a graduated glass or beaker. The mixture of blood and salt solution should be well agitated, and then 100 cc. of a saturated aqueous solution of picric

* 'Am. Nat.,' xiv. (1880) pp. 752-3.

† 'Traité technique d'Histologie,' i. (1875-78) p. 195.

acid added with constant stirring. After the corpuscles have settled, as much of the supernatant liquid as possible is poured off, and in its place is put about an equal volume of normal salt solution. The corpuscles are allowed to settle, the liquid poured off, and another volume of salt solution added. This is continued until the salt solution acquires only a faint yellow tinge. The use of the salt solution is, first, to dilute the blood in order to avoid distortion of the corpuscles, and second, to wash away the picric acid, so that the subsequent staining will be more satisfactory.

After pouring off the last salt solution, there is put in its place 10 cc. of a mixture of five parts of Frey's carmine and ninety-five parts of picrocarmine. The corpuscles will stain in from one to fifteen hours. A drop of the agitated mixture should be examined occasionally, to ascertain when the staining is sufficient. The nucleus should be deep red, and the body of the corpuscle yellow or pinkish.

When the staining is completed as much stainer as possible should be poured off, and in its place 10 or 15 cc. of acid glycerine (glycerine 100 cc., acetic or formic acid 1 cc.). This mixture of corpuscles and glycerine may be placed in a bottle and used at any time, it being simply necessary to agitate the mixture slightly or to take up some of the sediment with a pipette and mount it precisely as any other glycerine preparation.

The process consists, therefore, of these five steps:—

1. The fresh blood is first diluted with about fifty times its volume of normal salt solution. 2. To this diluted blood is added ten times as great a volume of a saturated aqueous solution of picric acid. 3. The picric acid is washed away with normal salt solution. 4. The corpuscles are stained with picrocarmine, or a mixture of this and Frey's carmine. 5. They are preserved in acid glycerine, and may be mounted for the Microscope at any time.

**Preparing and Mounting Wings of Micro-Lepidoptera.***—Mr. C. H. Fernald describes a method by which the wings of the micro-lepidoptera can be prepared so that the venation can be studied under the compound Microscope, in a manner that will leave no doubt of the presence or absence of the faintest vein in the whole wing-structure.

The removal of the scales by mechanical means he considers unsatisfactory, as also are the methods recommended for bleaching the wings, described by Chambers and Dimmock. When mounted dry by the latter method, the scales, although bleached, were not sufficiently transparent to show clearly the more obscure parts of the structure, and when mounted in Canada balsam, the entire wing was rendered so transparent that only the larger veins were visible, and it was found to be extremely difficult to get rid of the air-bubbles, which so readily gather under the concave portions of certain minute wings.

The author's method consists in mounting in cold glycerine; after having been bleached by Dimmock's method (which, for bleaching, is

* 'Am. Mon. Micr. Jour.,' i. (1880) p. 172. (Paper read before the Subsection of Microscopy of the Am. Assoc. Adv. Sci.)

to be recommended), the wings are transferred to the slide direct from the water in which they are washed, then allowed to dry (sometimes hastened by holding the slide over the flame of a lamp); and, when quite dry, a drop of glycerine is to be added, and the cover at once put on. When the glycerine has penetrated around the edges so as to completely saturate portions of the wing, the scales at once become transparent, and the structure is clearly apparent.

By holding the slide over the lamp till ebullition takes place, the glycerine will be found to replace the air under the concave portions of the wings, without any injury to the structure; and even in those refractory cases when the glycerine has been allowed to boil for a considerable length of time, no injury was found to be done to the wing-membrane.

**Microscopical Investigation of Wood.**—The Vienna Academy propose as the subject for the Baumgärtner prize of 1000 florins, "The microscopical investigation of the wood of living and fossil plants." By such investigation, and the comparison of all known recent and fossil woods, it is desired to ascertain characters whereby it will be possible to determine the genus and species with certainty from microscopical sections. Papers must be sent in before December 31st, 1882, and the prize will be awarded at the anniversary meeting in 1883.

**Permanent Preparations of Plasmodium.***—Two methods are already known for making permanent preparations of the motile or naked protoplasmic stage of the Myxomycetes; the older one being to dry the extended plasmodium, and the newer, to harden it with osmic acid. Both these methods are defective, for osmic acid changes the colour of the protoplasm, and drying causes it to shrink as well as to change colour.

Mr. S. H. Gage gives the following as a simple and efficient method of extension and preservation: Small pieces of the rotten wood, on which the plasmodium is found, should be placed on moistened microscope-slides, with some of the plasmodium touching the slides. These should be on a piece of window or plate glass, and over the whole should be placed a bell-jar, or other cover, to prevent evaporation. After an hour or more, the glass on which the slides rest should be lifted up to see whether the plasmodium has crawled out upon any of the slides. If any of the slides are satisfactory, lift off the bell-jar, and remove the pieces of wood from the slide, the plasmodium remaining. The slide should then be put very gently into a mixture of equal parts of a saturated aqueous solution of picric acid and 95 per cent. alcohol; it should be removed in fifteen or twenty minutes, and placed, for about the same length of time, in 95 per cent. alcohol; it may then be mounted in Canada balsam in the usual way, but without previous clearing. The picric acid stiffens the protoplasm almost instantly, but does not shrink it; the alcohol removes the water, and allows of Canada balsam mounting.

* 'Am. Mon. Micr. Journ.,' i. (1880) pp. 173-4. (Paper read before the Sub-section of Microscopy of the Am. Assoc. Adv. Sci.)

The method is especially good for the yellow plasmodium, as the colour is precisely that of the picric acid solution. If white plasmodium is to be mounted, it should be soaked in 25 per cent. alcohol, to remove the yellow colour of the picric acid, before anhydrating it with strong alcohol. Experiments have not been tried with plasmodium of purple and other colours to determine successful methods of preservation, but some slight modification of the above is confidently expected to succeed.

**Preparation of Green Algæ.***—Last summer Prof. O. Nordstedt collected at Jönköping the rare, and in many respects interesting, alga, *Sphæroplœa annulina*. This alga has the chlorophyll in the sterile cellules arranged in transversal bands or rings. As he tried to dry them, he found that the rings were destroyed by getting dry. He repeatedly tried to obtain good microscopical preparations by using "liquor Hantzschiæ," as well as acetate of potassium; but when unsuccessful, he applied warmth. He put a small bottle, containing the alga in water, on a black object, and exposed it to strong sunlight for a couple of hours. When the alga afterwards was dried, the rings proved to be pretty well preserved; when afterwards heated by a spirit lamp, the thermometer indicated that the rings when boiled

| | |
|---|---|
| ½ minute at 35°–40° Cels. | Did not keep, or were very badly preserved. |
| When boiled 5–10 minutes at 45° Cels., ½ minute at 50°–98° Cels. .. .. .. | The rings kept very well. |
| 10 minutes at 60° Cels., 2 minutes at 98° Cels. | The rings were separated from the membrane and placed in the centre alongside the cellule. |

It appears to be most convenient for the purpose to use 40°–50° Cels. during about two minutes.

In the *Spirogyra* the chlorophyll-bands, when the plant was boiled, also kept tolerably well; he, therefore, has often applied heat in preparing them. The different species seem to require different degrees of heat.

**Slides from the Naples Zoological Station.** — A provisional priced catalogue of the microscopical preparations issued by the Zoological Station at Naples † has now been published.‡ It includes 4 different preparations of Protozoa, 33 of Cœlenterata, 49 of Echinodermata, 33 of Vermes, 57 of Arthropoda, 54 of Mollusca, and 193 of Vertebrata.

The list is prefaced by an explanatory note by Dr. A. Dohrn, the Director of the Station, in which he points out that the microscopical preparations which have hitherto been sold "have only in rare cases a true scientific value. For this they must not only be prepared by hands well skilled in the technical processes, but there must also be the understanding of scientific problems and points of view," so that the preparations may exhibit just those points which are of importance

* 'Grevillea,' ix. (1880) pp. 37–8 (from 'Bot. Notiser').

† See this Journal, *ante*, p. 700.

‡ 'MT. Zool. Stat. Neapel,' ii. (1880) pp. 238–53.

scientifically. The slides are prepared under the superintendence of Mr. F. Meyer of Leipzig, who at Dr. Dohrn's request undertook this department. They are of the ordinary English size, and their price varies from 1 to 10 francs.

**Aeroscopes.***—In his studies on the microscopic organisms contained in the atmosphere, M. P. Miquel describes two forms of aeroscopes in use at the Montsouris Observatory for collecting such organisms.

M. Miquel objects to Dr. Maddox's "aeroconiscope," † that the quality of air passing during each experiment cannot be calculated, so that the statement of the number of germs collected has no definite signification. In his opinion, it is preferable to make use of apparatus capable of acting in all weathers, during rain and squalls as well as in fine weather.

Fig. 105 represents his "aeroscope à aspiration," which is composed essentially of two parts—the bell A, which is solidly fixed at 2 metres from the ground, and the cone B, which is screwed to A. The former has an aspiring tube placed in communication with a trumpet, and the

Fig. 105.

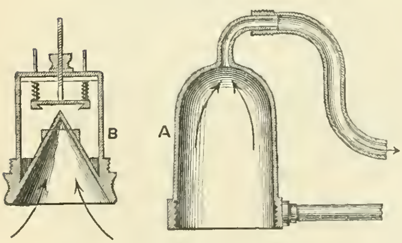
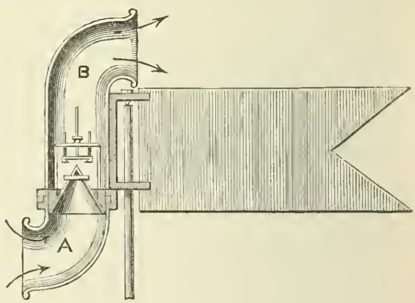



Fig. 106.




latter has at its upper part a very fine aperture, by which the air is directed to the centre of a thin glass plate smeared with a mixture of glycerine and glucose. This plate, which is kept in a horizontal position, may be brought nearer to the summit of the cone, or *vice versâ*. The air aspired by the trumpet, after having passed through the apparatus, is received in a meter, which measures its volume exactly.

A second instrument ("aeroscope à girouette") is shown in Fig. 106. It operates by the action of currents of air, and is used only to analyze the air qualitatively when the other form cannot be employed. Like the apparatus of Drs. Maddox and Cunningham, it is light and portable, but in the same time gives 100 times as many germs. It is in the form of an *S*, and consists of the chambers B (united to a vane, so that the upper bell-shaped aperture is kept constantly opposite to the wind), and A carrying a thin glass plate and a conical

* 'Brebissonia,' ii. (1880) p. 147.
† 'Mon. Micr. Journ.,' June, 1870.

diaphragm, and having its lower aperture turned in the direction of the currents. The apparatus set upon a vertical axis is acted upon by the feeblest currents. A Robinson anemometer serves to measure the velocity of the air during the experiment, and to estimate approximately the volume which has passed through the apparatus.

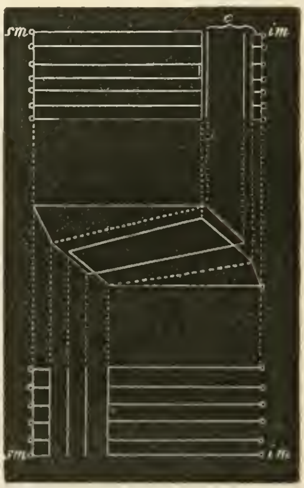
Both forms were originally constructed of glass, but are now made of copper nickelled.

**Microscopical Appearance of the Valves of Diatoms.***—This paper by Mr. Julien Deby is written with the view of enabling microscopists more readily to *interpret* the appearances presented by diatoms as seen under the Microscope, which is often very difficult with transmitted light. By an attentive examination, however, of the details, "even the most incomprehensible problems will be resolved as if by enchantment."

Taking *Nitschia* as the first type, the author divides the different forms into two principal divisions—those in which the two sections of a valve meet at an acute angle, and those which meet at an obtuse angle, each of which divisions may have the valve-sections plane or curved. These four divisions may each be subdivided into three others, according as the midrib is central, normally excentric, or submarginal (that is, with one of the valve-sections nearly obsolete).

The author then gives diagrams of the appearances of various forms, of which we can only subjoin one—Fig. 107 (*sm.*, *im.*, upper and lower midrib; *c*, connective). This shows a *Nitschia* with valves whose two sections form an acute angle, and with an excentric midrib. Taking the line which represents the surface of either of the larger sections as a horizontal, and drawing the perpendiculars, we shall have the true microscopical projection of the diatom when viewed from the upper or under side respectively.

Fig. 107.




The author considers that it is necessary to pay more attention to details than has hitherto been the case in this difficult genus, and in defining every species (1) to describe the general form of the frustule, and the relations of the length of the two sections of the valves to the breadth; (2) to indicate the position of the midrib by reference to the imaginary central line of the valve, that is to indicate the relative size of the two sections; (3) to determine the number of striæ by reference to the nodules of the midrib; (4) to count the siliceous grains of the midrib, the striæ of the valve sections, and the number of points per stria per micro-millimetre; (5) to indicate if the valve is acute or obtuse, and its sections plane or curved.

* Sep. repr. 'Ann. Soc. Belg. Micr.,' v. (1880), Mém., 16 pp. and 20 figs.

**Cleaning Diatoms with Soap.***—Dr. H. Stolterfoth having tried to clean some of the Welsh deposits by the common acid process, which gave very poor results, even alkalies destroying the valves of the larger *Surirellæ* before they were free from the dirt, boiled them in soap and water for about an hour, with excellent results. The process is also applicable to all kinds of fresh- and salt-water deposits.

The method is this: Place in a test-tube (6 inches by 1 inch) a portion of the earth, about $\frac{1}{4}$ inch in depth, and pour in water till the tube is one-fourth full; into this drop a piece of common yellow soap, about the size of a small pea, and boil gently over a lamp. The solution should be examined under the Microscope from time to time, by taking out a drop with a dipping-tube, and putting it on a slide; as soon as it is seen that the valves are clean, fill up the test-tube with cold water, and let it stand, then wash in the usual way, until all trace of soap is removed.

In pouring on the cold water after the boiling, the solution is quite fluid as long as the water is warm. During this time the diatoms fall to the bottom, but, on getting cold, the solution assumes a somewhat jelly-like consistency, and holds the fine particles and mud in suspension, and is a very useful means of getting rid of what is often a great trouble.

In deposits in which there is much organic matter, recourse must still be had to acids or fire to destroy this, but the result will be improved by afterwards boiling in soap and water. The author has also boiled fresh gatherings in soap and water, and then burnt on platinum foil with good success, much of the flocculent matter being removed.

Dr. E. Kaiser, of Berlin, referring to this paper, says † that the process was communicated to him several years ago from England, but that "it has very many defects and inconveniences."

**Separation of Heavy Microsopic Minerals.‡**—In order to separate minute particles of heavy minerals, of different specific gravities, from each other, M. René Bréon proposes to employ a mixture of the fused chlorides of lead and zinc, the respective specific gravities of these two liquids being 5 and 2·4, so that by properly proportioning the mixture, any two minerals of different specific gravities, but lying within the above limits, can be separated. The fine powder to be experimented on is thrown into the fused chlorides contained in a conical glass tube, when the particles speedily come to rest, some floating, and the others sunk at the bottom of the tube; the mass is then allowed to cool, and when set, the tube is plunged into cold water, thus cracking the glass. The upper and lower portions of the mass of chlorides containing the minerals can then be removed, and the chlorides dissolved out with water acidulated with hydrochloric acid.

**Pearson-Teesdale Microtome.**—At the October Meeting Mr. Washington Teesdale exhibited a small and convenient form of micro-

* 'Journ. Quek. Micr. Club,' v. (1880) pp. 95–6.
† 'Bot. Centralbl.,' i. (1880) p. 1213.
‡ 'Bull. Soc. Min. France,' iii. See 'Mineralog. Mag. and Journ. Mineralog. Soc.,' iv. (1880) p. 129.

tome, for amateur use, made by Mr. A. A. Pearson, of Leeds. The instrument is shown in Figs. 108 and 109, and was thus described by Mr. Teesdale :—

"In general form it is based upon the Continental model of Dr. Schiefferdecker, of Strassburg,* but it is more compact, and small objects are more readily held or packed, as the holding or grasping

FIG. 108.

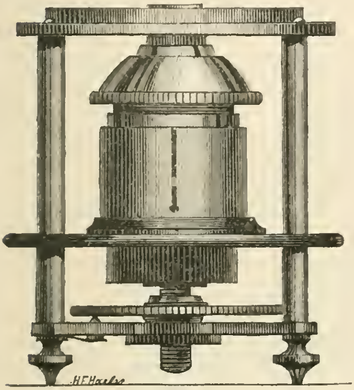
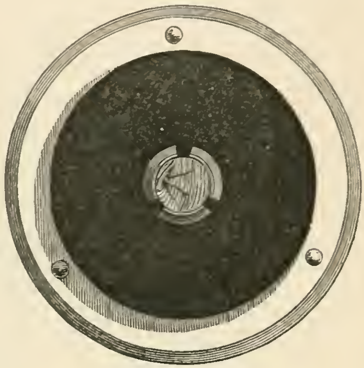


FIG. 109.



is effected by jaws closing centrally like those of an American chuck. The object so held is raised by a double-threaded screw of 50 per in., metrically equal to (but possessing some advantage over) one of 25 threads per in. Its elevation is regulated and recorded by a circular plate and spring stop catching in 20 equal divisions, each one of which indicates an advance of $\frac{1}{500}$ in. In practice I have generally found about $\frac{1}{250}$, in two divisions of this graduation, the most convenient average thickness for vegetable sections.

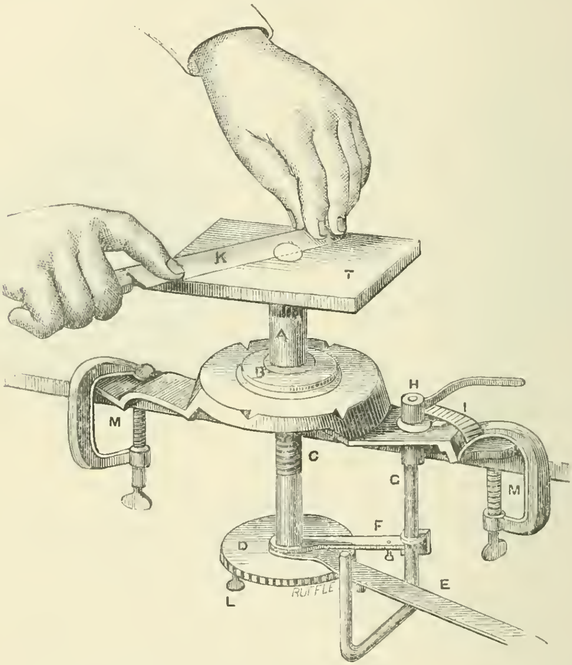
I have used most of the forms of ordinary section-cutters for nearly twenty years. Some are ingeniously contrived and good in theory, or suitable for some special purpose, but have some practical fault or inconvenience for the general all-round work of an amateur. The Strassburg model which furnished the basis of the design of this, was, it appeared to me, an excellent one, and the principle of its construction sound, inasmuch as the object was not irregularly forced up by pressure from beneath, but held firm, and had the cutting table or guide-plate lowered by screw and graduated index. Such intelligent mechanical aid to accuracy and facility ought, and would, assuredly have obtained favourable recognition and general adoption, but, unfortunately, in copies of it made and distributed in England the screw was cut taper in the lathe (instead of being cut perfectly parallel with stocks and dies), consequently the instrument was somewhat shaky."

* 'Quart. Journ. Micr. Sci.' (1877) p. 35.

**Hailes' Poly-microtome.***—This instrument, shown in Figs. 110 and 111, is the design of Dr. W. Hailes, Professor of Histology, &c., at Albany Medical College (U.S.A.), who thus describes it:—

This instrument is designed especially for use in the working

Fig. 110.




Poly-microtome (without freezing apparatus). A, small well, fitting on pyramidal bed-plate. B, pyramidal bed-plate, containing different sizes. C, micrometer screw. D, ratchet-wheel attached to screw. E, lever actuating the micrometer screw by means of a pawl engaging in teeth of ratchet-wheel. F, arm, carrying a dog, which prevents back motion of screw. G, regulator for limiting the throw of lever, and consequently governing the micrometer screw. H, lever-nut for fixing regulator. I, index, with pointer and graduated scale, from $\frac{1}{2400}$ inch to $\frac{1}{200}$ inch. K, knife for cutting sections. L, knob to turn micrometer screw direct when pawls are attached. M, table-clamp. T, table of microtome, with glass top to facilitate cutting.

laboratories of medical schools and colleges, where large numbers of sections are required for microscopical examination. It may be employed as a simple instrument or as a freezing microtome, arranged for ice and salt—ether spray, phigoline, &c.

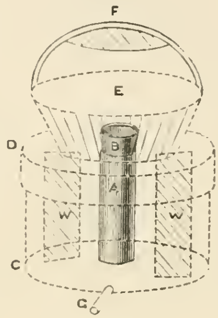
The employment of ice and salt (coarse) is preferred, because it costs but little and freezes the mass solidly and quickly, and, if desired, 500 or 1000 sections can be obtained in a few moments.

* 'Science,' i. (1880) p. 187. (2 figs.)

Time of freezing is about seven minutes, except in very warm weather, when it requires a few moments longer. The instrument does not work so satisfactorily in warm weather, owing to the rapid melting of the surface of the preparation. It is absolutely necessary that the mass should be frozen solid, or the sections cannot be cut smoothly. An extra freezer may be employed, and while one specimen is being cut the other may be frozen, and by exchanging cylinders (they being interchangeable) no delay is necessary to its continuous operation.

The art of cutting is readily acquired, and when the preparation is frozen it is the work of a few moments to obtain several hundred sections. Two hundred sections or more, if desired, can be made each minute and of a uniform thickness of about $\frac{1}{200}$ of an inch (thinner or thicker, from about $\frac{1}{2400}$ inch to about $\frac{1}{200}$ inch, according as the pointer is set). The delivery, ease, and rapidity with which they can be cut, must be seen in order to be appreciated. It is not necessary to remove the sections from the knife every time, but twenty or thirty may be permitted to collect upon the blade; they lie curled or folded up upon the knife, and when placed in water straighten themselves out perfectly in the course of a few hours. The knife is an ordinary long knife from an amputating case.

Fig. 111.




A, B, tube containing specimen, which is surrounded by freezing mixture in the receiver C, D. E, F, revolving hopper, with wings W, W, for stirring the ice. G, outlet for melted ice.

Perfectly fresh tissues may be cut without any previous preparation, using ordinary mucilage (acaciæ) to freeze in, but most specimens require special preparation. If preserved in Müller's fluid, alcohol, &c., they require to be washed several hours in running water; then according to the suggestion of Dr. D. J. Hamilton,* the specimen is placed in a strong syrup (sugar, two ounces; water, one ounce), for twenty-four hours, and is removed to ordinary mucilage acaciæ for forty-eight hours, and is then cut in the freezing microtome.

The sections may be kept indefinitely in a preservative fluid: ℞ glycerinæ, ℥iv; aquæ destil. ℥iv; acidi carbolici, gtt. iij; boil and filter. The addition of alcohol ℥ij is advisable.

**Salicylic Acid as a Preservative.**†—Mr. A. Mickle has had very good success with salicylic acid in mounting vegetable preparations of all kinds. One difficulty, however, is that it dissolves very sparingly in water, and alcohol produces changes which are frequently undesirable. It is well known that salicylic acid dissolves freely in a solution of borax, and it is also familiar to most persons that borax

* See "A New Method of Preparing Large Sections of Nervous Centres for Microscopical Investigation."—'Journ. Anat. and Phys.,' vol. xii.

† 'Am. Journ. Micr.,' v. (1880) p. 185-6.

itself is quite efficient as a preservative. It therefore occurred to him to combine them, two parts of salicylic acid and one part of borax dissolving completely in half an ounce of glycerine—this solution, when mixed with three parts of water, forming an excellent preservative fluid for coarse organisms. More delicate preparations should be mounted in the above solution diluted with five parts of water.

Preparations so mounted are very durable, and there is no danger of the salts crystallizing out and spoiling the object, and, in addition, it is very easily kept in a cell of almost any kind.

**Dry "Mounts" for the Microscope.***—Prof. Hamilton L. Smith, referring to his former paper,† in which he described the methods which he had found tolerably successful, viz. the rings made of shellac and lampblack, and those punched out of gutta-percha tissue, further says that the former appear to answer quite well, and the changes if any are very slight, yet he has in a very few cases observed a deterioration after the lapse of a year or so, probably from imperfect manipulation. Although he has not observed any great change in the gutta-percha mounts, he is not certain they will stand prolonged use with immersion objectives without injury. Messrs. Spencer are decidedly of opinion that the shellac ring is the better for durability; and Mr. Gundlach says that the gutta-percha ring will not stand cedar oil. Dr. Phin has suggested that in time the gutta-percha tissue will disintegrate, but the author has not yet noticed this, and does not think it will happen under the cover of a "mount," especially if protected by a ring of cement subsequently applied. If it does, it will of course be a great objection to its use. The "tissue" becomes so charged with electricity by handling, and also by punching, that it interferes seriously with the latter operation, and thus makes it necessary to place strips of the "tissue" on thin moistened strips of paper, and to punch out both at the same time. The preparation of the shellac rings by the turntable obliges one to keep on hand a large stock all the time, to ensure perfect drying and to have them always ready. The author is obliged to have some 1000 or 1500 on hand in advance, and this necessitates a considerable outlay in stock which will not always be convenient for amateurs.

For the above reasons, a new process is now proposed which appears to meet all the desired wants, and which combines the advantages of the shellac cement and the gutta-percha rings. The author says that "the very simplicity of this process causes him to wonder why it was not thought of before."

Take a sheet of thin writing paper, white or coloured, and dip it into thick shellac varnish (shellac dissolved in alcohol), and hang it up to dry. When thoroughly dry, it should have a good glaze of the varnish on it (different thicknesses of paper can be used according to depth of cell required). Out of this shellac paper cut the rings, and these can be made in any quantity, and kept for any time. The process of mounting is simple. The slide is cleaned and the flat paper ring placed in the centre; on this the cover is placed, having

* 'Science,' i. (1880) p. 74. † See this Journal, *ante*, p. 861.

the object dried on it, and the two are held together by the forceps and gently warmed; this serves to attach the ring to the slide and cover at several points, so that the forceps may now be laid aside. The next step is to take a glass slip (another slide), and laying this on the cover, to grasp the two slides at each end by the finger and thumb of the two hands, and pressing them tightly together, to warm the slide gently; by looking at the ring obliquely on the under side one can tell at once when all the air is pressed out, and the adhesion is complete between the cover and the ring, and also the ring and the slide, and they must be held together a moment or two to cool. If the lac is sufficiently thick on the paper, the adhesion takes place quickly, and with moderate heat, and there will be no danger of breaking the cover, unless it has been warped in the process of warming, which will sometimes occur when very thin glass has been heated too much for the purpose of burning off the organic matter, or when the support is too small in diameter, or when it is not flat.

The author, in conclusion, says, "I cannot conceive of anything more satisfactory than these rings. Many large objects which would be crushed if one used only the shellac rings made on the slide by the use of the turntable, by the giving way of these by softening, and under the necessary pressure for attaching the cover, are perfectly protected by the paper rings. I am satisfied that the balsam mounts will be much less frequently used as soon as we can find some *sure* dry process. The diatoms as a rule show much better when mounted dry, and with whole frustules, exhibiting both the side and the front view, also the mode of attachment, &c. The dry mounts are certainly to be preferred when they are desired for anything except pretty objects, and even for this latter purpose there is often a very great difference in favour of the dry mount. Although I have not used these shellac paper rings for any very great length of time, yet I can see no reason why they should not be equal to the simple shellac ring for durability, and very much superior to it in other respects."

We should note, in regard to this suggestion of Prof. Hamilton Smith, that the rings above referred to were the subject of a paper read to this Society by Mr. James Smith * in 1865.

Dr. Phin has found, he says,† "that pure shellac in all its forms is very apt to separate from the glass after a time.

**Wax Cells.**‡—Dr. Phin does not appear to be disposed to abandon these cells, as suggested by their originator (Prof. Hamilton L. Smith). He has carefully examined a number of slides of the mounting material of which wax forms a part. Some were found to be spoilt, others were good. It is evident that the dew may arise either from

* 'Trans. Micr. Soc. Lond.,' xiv. (1866) p. 29. The following is an extract from Mr. James Smith's paper:—"Both surfaces of the cardboard [are to be] covered with a cement formed of shellac or marine glue dissolved in naphtha; one to three coatings of this cement being usually sufficient, care being taken that one is perfectly dry before the next is applied. The cells being thus prepared, they can be cut off, and by the application of heat and slight pressure are easily attached to a glass slide."

† 'Am. Journ. Micr.,' v. (1880) p. 203. ‡ Ibid.

the object itself or from the mounting material. In the case of such objects as Polycistina and diatoms which have been exposed to low red heat, it is unlikely that any vapours would ever be given off, and slides of these objects have been found both with dew and free from it. A good deal probably depends upon the quality of the wax and the processes used in bleaching it. Where bleached by exposure to sunlight and water, and afterwards carefully melted, it is believed no vapour will be given off. Where the wax has been bleached by the action of acids and chlorine it is difficult to tell what changes may occur.

Amongst the directions for mounting in wax cells, one which has been generally given and very usually followed, is to soften the wax with turpentine at the point where the object is to be placed. When this has been done, and the cell closed immediately, the turpentine is sure to evaporate and settle on the cover. It there becomes oxidized or ozonized, so that it is no longer volatile, and it was undoubtedly this ozonized turpentine which resisted the high temperature alluded to by Prof. Smith. Instead of turpentine, a copper wire should be used. highly heated, and held near but not in contact with the wax.

To the same tenor are the remarks of Mr. C. F. Cox and Mr. J. F. Stidham.* The former points out that while if the ground for condemnation—" dew " on the cover-glass—were found exclusively in the case of wax cells, it might be fair to infer that the cause was the wax, yet as it is found more or less in cells of all kinds, and is not worse in wax cells than in most others, the denunciation by Prof. H. L. Smith of his own invention is not justified. The misty condensation may possibly be caused in some cases by emanations from the sheet wax, but Mr. Cox's experience goes to prove that it is mainly due to the too free use of cements containing resinous or oily solvents, like turpentine or benzole, though sometimes it may arise from the want of dryness in the object itself, or a recrystallization of chemical constituents of the cements, as the Professor suggests. If a cement is used, composed of shellac dissolved in alcohol, plenty of time allowed for the completion of each step, no more cement used than is necessary, and the specimen itself thoroughly dry, the cell will be free from vapour and condensations, and he is therefore of opinion that the wax cell is " the best cell for dry objects that has ever been used."

Mr. Stidham's testimony is to the same effect. He " has found no trouble since covering the whole cell with a thin film of shellac, and using shellac to fix the cover, provided the *day was a dry one*, and the cover is held for a moment over the lamp flame." He thinks Mr. C. C. Merriman's suggestion of leaving a small opening so that moisture may get out would be of practical advantage if it can be done.

**Improvement in Making Wax Cells.**†—For making wax cells, when they are wanted smoother and handsomer than they can be made with a punch alone, Mr. J. D. White recommends the following

* 'Am. Journ. Micr.,' v. (1880) p. 207.
† 'Am. Mon. Micr. Journ.,' i. (1880) p. 150-1.

process as simpler and easier than that of Dr. Hamlin, described on page 507.

With home-made punches of ordinary brass tubing (cartridge cases answer very well), cut out rings and disks a little larger than the finished cells are to be, and fasten them to the sides by pressure and gentle warmth, after centering as accurately as possible. Then, with a tool made by bending a small chisel at a right angle about half an inch from the edge, turn or scrape the cell on a turntable until it is of the right size. If the tool is sharp, a beautifully polished surface will always result. The chisels which accompany sets of brad-awls are just right; but any flat piece of steel, if not too heavy or clumsy, will do. The cutting edge should be about one-fourth of an inch wide. Punches, and all tools used for cutting wax, should always be dipped or moistened in starch, prepared precisely as for laundry use; this operates much better than water, or indeed anything else.

**Atwood's Rubber Cell.***—Mr. H. F. Atwood calls attention to a cell for opaque objects made of hard rubber highly polished.

Fig. 112 is a sectional view of the cell, the dotted line indicating the position of the thin glass cover. The base is solid, giving a black background of rubber, and round the top is a ledge fitted to receive a ½-inch cover-glass, which may be secured by a little shellac or similar cement.

FIG. 112.

The cell is claimed to be specially advantageous in two ways:—1st. It solves the problem which often perplexes the collector who is crowded for cabinet room. Many objects for future reference may be mounted, numbered, and put away without a slide, a cabinet drawer holding 200, while but 40 slides could be accommodated in the same space. 2nd. In exchanges the cells may be sent through the post without glass slips, so that there is a saving in postage and no risk of breakage.

Mr. Atwood suggests that the cell "may be attached to a glass slip by any cement before or after preparation." Our own experience is that rubber is by no means easy to attach securely, and that some other means of examining the cells under the Microscope will be necessary. In this view, Messrs. Beck have devised a circular cell-holder, in ebonite, holding 12 cells, which lies upon the stage, and can be rotated so as to bring each cell successively under the objective.†

**Parkes's Frog-plate.**—Instead of the ordinary method of examining the circulation of the blood in the frog's foot, which is attended with some degree of inconvenience, at any rate, to the animal, the following plan is recommended:—

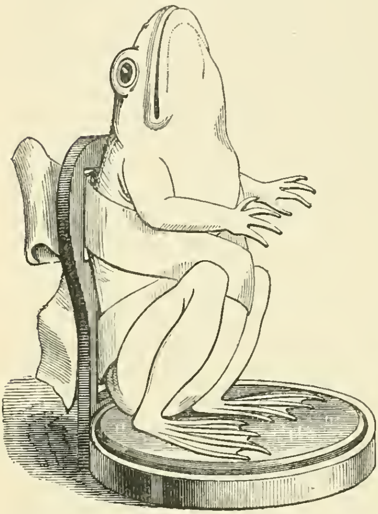
Put the frog into an empty wide-mouthed bottle (such as a pickle-jar), cover the cork with a piece of linen rag, on which pour a little sulphuric ether, and then insert the cork immediately, and lay the bottle on its side. In a few minutes the animal will be sufficiently

* 'Science,' i. (1880) p. 200.

† A description of this holder, with a figure, will be given in the next number.

etherized * without affecting the circulation, and may then be placed on the frog-plate, shown in Fig. 113, in an erect position, with its feet on the circular glass, a little soft tape being placed—not too tightly—round the body to keep it erect. The web of the foot may now be moistened with a little cold water, and the plate laid on the stage for examination.

Fig. 113.



If sufficiently etherized, the frog will remain perfectly quiet for half an hour, and both feet may be examined alternately. The toes must of course be spread out so as to stretch the web, which should be moistened occasionally with a camel-hair pencil dipped in cold water. The process may be repeated many times on the same frog if carefully managed, but after each examination it should be put into a vessel with a little cold water, till it recovers consciousness.

**Sternberg's Culture-cell.**†—There are many experiments in which a culture-cell is required which will preserve the blood in a fluid condition, free from atmospheric contamination, and yet surrounded by a sufficient amount of air to furnish the necessary oxygen to organisms that may develop from any germs that may be present in the blood. In addition to this it is necessary that a very thin stratum of blood should be within reach for examination by the highest-power immersion objectives.

The Boldeman cell fulfils the first requirement. A central eminence is surrounded by a circular channel, ground in the glass, which serves the purpose of an air-chamber. The summit of the central eminence is slightly concave, and the drop of fluid to be observed is placed upon this and protected with a thin glass cover, which is attached to the slide by a circle of cement, or simply by a little oil.

The main objection to this cell was found by Mr. G. M. Sternberg, Surgeon U.S. Army, to be that the stratum of blood held in the shallow cup of the central eminence was too thick for satisfactory examination with high powers; that portion of the fluid next the cover, which could be brought into focus, being shut off from the

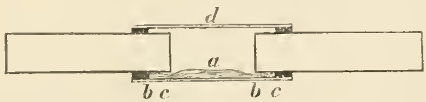
* It may always be known when the frog is fully under the influence of the ether, by placing it on its back, before taking it out of the bottle, as it will not remain quietly in this position except when etherized.

† 'Am. Mon. Micr. Journ.,' i. (1880) pp. 141-3. 1 fig.

light by floating corpuscles in the background. And this difficulty led him to invent the following culture-slide.

A circular hole, about $\frac{1}{4}$ inch in diameter, is drilled through the centre of a glass slide. A very thin circle of cement, $\frac{1}{2}$ inch in diameter, is then turned about this central hole on one side of the slide, and a thin glass cover is attached to it by gentle pressure. When the cement is thoroughly dry, the cell is ready to receive the drop of blood, or other fluid which is to be observed. This is placed in the bottom of the cell (*a*, Fig. 114), and flows by capillary attraction into the space below, between the thin cover and the slide, until it extends to the circle of cement by which the cover is attached.

FIG. 114.




We have thus a thin stratum of the fluid between the points *b* and *c*, which may readily be examined by inverting the slide and bringing an immersion lens down upon any point between the central air-chamber and the circle of cement by which the cover is attached. Finally, the cell is closed by turning a still larger circle of cement upon the upper surface of the slide, and attaching a larger thin glass circle (*d*).

Mr. Sternberg does not see why it should not also serve a good purpose as a cell in which to mount objects either dry or in fluid. If the manufacturers would furnish glass slips of different thicknesses, having central perforations of $\frac{1}{4}$ to $\frac{1}{2}$ inch in diameter, a thin glass cover can easily be attached to make the bottom to the cell; and these might, for many purposes, replace the various cells in common use.

**Apertures exceeding 180° in Air.**—Mr. Shadbolt's note on this subject will be found in the Proceedings of the November Meeting, *infrà*, p. 1089.

**Visibility of Minute Objects — New Medium for Mounting** (*Monobromide of Naphthaline*).—Professor Abbe has recently been experimenting upon substances adapted for mounting diatoms (having regard to the suggestions made in Mr. Stephenson's recent paper *), and has discovered that monobromide of naphthaline is very suitable for the purpose, and does not present the inconveniences of some of the other substances.

The liquid is colourless and oleaginous, with the odour of naphthaline. It is soluble in alcohol and ether, and has a density of 1·555, with a refractive index of 1·658, giving therefore as the "index of visibility" 22 as against 11 for Canada balsam. It is not volatile.

Dr. H. van Heurck refers to this substance, some of which was sent him by Mr. Zeiss. His experiments with it have given the best

* See this Journal, *ante*, p. 564.

results, the diatoms mounted in it showing with "excessive beauty." The striæ of *Amphipleura pellucida*, amongst others, were clearer than he ever before saw them. Objectives, with which he had never been able to see the striæ by simple lamp-light, showed them at once in the new medium. He considers, therefore, that its employment will be found very useful wherever the delicate details of diatoms are not sufficiently visible in ordinary preparations.

Dr. L. Dippel, also writing * on Mr. Stephenson's paper, commends oil of aniseed and oil of cassia for mounting, the last of which has especially proved to be well adapted for making the fine structure of the siliceous valves clearly visible. He has recommended both oils for some years to one and another of the German mounters. Oil of aniseed was employed by Professor Weiss in studying diatoms.†

Of the fluids which Mr. Stephenson further proposes, the solution of phosphorus in bisulphide of carbon is, Dr. Dippel considers, precluded on account of its combustibility, and mounting in bisulphide of carbon as well as in the solution of sulphur is attended with so many inconveniences that neither could well be taken into common use as fluids for mounting. On the other hand, monobromide of naphthaline is most excellently adapted for it. It does not affect wax as far as experience has gone as yet, and hence objects may be conveniently prepared with it. The cover-glass should be run round with a ring of wax, then with a cement of isinglass dissolved in spirit (called Heller's porcelain cement), or Canada balsam, rather thick, dissolved in chloroform; finally closing with a solution of shellac. Amongst other diatoms thus mounted, is a small and very finely striated *Amphipleura pellucida*, the structure of which, with immersion objectives—homogeneous-immersion specially—appears wonderfully clearly and sharply defined.

**Absolute Invisibility of Atoms and Molecules.**‡—Professor A. E. Dolbear writes:—

Maxwell gives the diameter of an atom of hydrogen to be such that two millions of them in a row would measure a millimetre; but under ordinary physical conditions most atoms are combined with other atoms to form molecules, and such combinations are of all degrees of complexity. Thus, a molecule of water contains three atoms, a molecule of alum about one hundred, while a molecule of albumen contains nine hundred atoms, and there is no reason to suppose albumen to be the most complex of all molecular compounds. When atoms are thus combined, it is fair to assume that they are

* 'Bot. Centralbl.,' i. (1880) p. 1148.

† Dr. Dippel, if we understand him correctly, also points out that "this method of preparation is not in all respects new. He himself came upon it in his investigations on the cell-wall ['Das Mikroskop,' i. pp. 67 and 83], and since 1867 has mounted not only histological objects, but also various diatom preparations in oil of aniseed and oil of cassia." We need hardly, however, mention that the point of Mr. Stephenson's paper is not to describe *as a novelty* the use for mounting of phosphorus, bisulphide of carbon, &c.; for, as he says in the paper, preparations were so mounted in 1873, when his previous paper was read.

‡ 'Science,' i. (1880) p. 150.

arranged in the three dimensions of space, and that the diameter of the molecule will be approximately as the cube root of the number of atoms it contains, so that a molecule of alum will be equal to

$$(\sqrt[3]{100} = 4 \cdot 64) \frac{4 \cdot 64}{2000000} = \frac{1}{431000} \text{ mm.},$$

and a molecule containing a thousand atoms will have a diameter of $\frac{10}{2000000} = \frac{1}{200000}$ mm.

A good Microscope will enable a skilled observer to identify an object so small as the $\frac{1}{4000}$ mm. Beale, in his works on the Microscope, pictures some fungi as minute as that; and Nobert's test bands, and the markings upon the *Amphipleura pellucida*, which are about the same degree of fineness, are easily resolved by good lenses. If thus the efficiency of the Microscope could be increased fifty times ($\frac{200000}{400} = 50$), it would be sufficient to enable one to see a molecule of albumen; or if its power could be increased one hundred and seven times, it would enable one to see a molecule of alum.

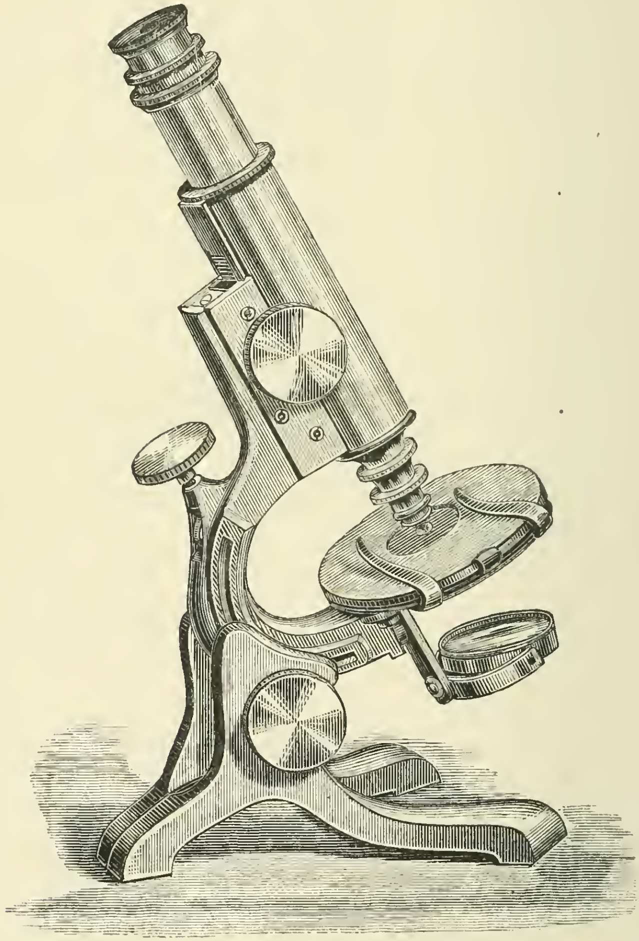
Now, Helmholtz has pointed out the probability that interference will limit the visibility of small objects; but suppose that there should be no difficulty from that source, there are two other conditions which will absolutely prevent us from ever seeing the molecule.

1st. Their motions. A free gaseous molecule of hydrogen at the temperature of 0° C., and a pressure of 760 mm. mercury, has a free path about $\frac{1}{10000}$ mm. in length, its velocity in this free path being 1860 m. per second, or more than a mile, while its direction of movement is changed millions of times per second. Inasmuch as only a glimpse of an object moving no faster than one millimetre per second can be had, for the movements are magnified as well as the object itself, it will be at once seen that a free gaseous molecule can never be seen, not even glimpsed. But suppose such a molecule could be caught and held in the field so it should have no free path. It still has a vibratory motion, which constitutes its temperature. The vibratory movement is measured by the number of undulations it sets up in the ether per second, and will average five thousand millions of millions—a motion which would make the space occupied by the molecule visibly transparent, that is, it could not be seen. This is true for liquids and solids. Mr. D. N. Hodges finds the path of a molecule of water at its surface to be ·0000024 mm., and though it is much less in a solid, it must still be much too great for observation.

2nd. They are transparent. The rays of the sun stream through the atmosphere, and the latter is not perceptibly heated by them, as it would be if absorption took place in it. The air is heated by conduction contact with the earth, which has absorbed and transformed the energy of the rays. When selective absorption takes place, the number of rays absorbed is small, when compared with the whole number presented, so that practically the separate molecules would be too transparent to be seen, though their magnitude and motions were not absolute hindrances.

**Wale's "Working Microscope."**—The new feature of this instrument by Mr. G. Wale (Fig. 115) consists in the method of suspending the main limb carrying the optical body, so that it may be inclined at any angle. It is suggested that the ordinary method changes the position of the centre of gravity of the instrument so considerably as to render it more or less unsteady, while the new method avoids the difficulty, and at the same time furnishes a secure and convenient means of clamping the body at any position.

Fig. 115.



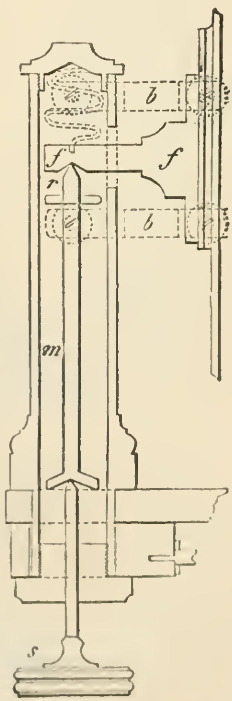
The stage and optical body are supported on the curved limb, which is nearly a semicircle, as shown in the figure. This limb has sectoral grooves about 90° in arc on either side, and slides between corresponding curved jaws, on the inner side of the upright pieces of the foot. The foot itself is made in two symmetrical pieces fitting together, and grasping the limb by means of a screw, of which the milled head is seen at the right-hand side of the instrument. By loosening this screw somewhat the curved limb is released; the sectoral grooves then permit it to slide between the jaws of the foot until the tube reaches the desired position (vertical, horizontal, or an intermediate position), when it may be clamped by tightening the screw.

The fine adjustment moves the entire body by a lever in contact with the screw (milled head) shown on the back of the limb, the distance between the eye-piece and the objective not therefore changing.

The rotating stage-clips can be applied to hold the object on either side of the stage, as described and figured in vol. ii. (1879), p. 623, where this Microscope was briefly alluded to.*

**Seibert and Krafft's Fine Adjustment.**—We referred on p. 883 to this fine adjustment (Figs. 99 to 101), citing an explanatory passage from Nägeli and Schwendener's 'Das Mikroskop.' The accompanying figure (Fig. 116) from the same authors will enable the reader to understand the mechanism, and the description will correct a slight inaccuracy (in the original) relative to the non-displacement of the optic axis.

Fig. 116.




The focussing-screw *s* acts upon the funnel-shaped head of the pivot *m*, the upper end of which acts in a similar manner upon *ff*, the solid bar attached to the optical body. The ring *r*, which serves as a guide-piece, lies loose in the hollow column, and as a rule does not touch the pivot; its function is merely to prevent the point of the pivot from slipping out of the notch in *ff*. The cross-bars *b b* (two on each side) are attached by screws to the hollow column, and the optical body is held between the points of four screws near the front ends of the bars. The focussing motion is communicated to the solid bar *ff* by the screw *s* acting against the pressure of the spiral spring shown above by dotted line, the friction being confined to the eight screw-points of the four cross-bars. The movement is similar to that of an ordinary parallel ruler with connecting bars, the hollow column being the stationary side.

It is obvious from an inspection of the figure that the optical axis must suffer a slight displacement. Any movement of the focussing screw *s* upwards or downwards from the normal position as shown, will cause the cross-bars *b b* to assume a diagonal position; the pivot *m* will consequently incline from its base backwards, and the solid

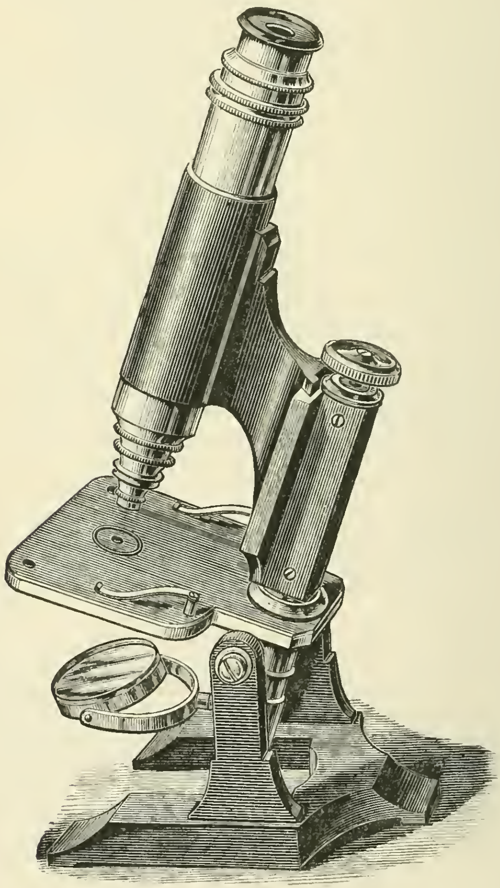
* See also Dr. Carpenter's observations on this Microscope, *infrà*, p. 1086.

bar *ff* will be drawn in the same direction, and with it, of course, the optic axis.

This method of fine adjustment presents difficulties in combination with a rotatory stage, and for comparative micrometrical measurements. The position of the milled-head at the *lower end* of the column is, however, very convenient, as the hand rests on the table while focussing.

"Sliding" Objectives. — The Microscope shown in Fig. 117 (Parkes's "English Medical Microscope") is provided with a "patent

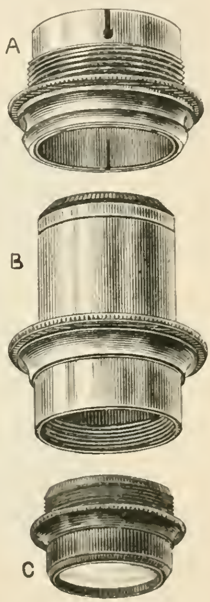
Fig. 117.



sliding adapter," for enabling the powers to be applied and changed very rapidly, without the loss of time occasioned by screwing. It is claimed that this plan will be found to save much time in cursory examinations, such as medical men have frequently to make.

In Fig. 118 A is the adapter, shown natural size (having the Society screw, it fits any Microscope); this adapter contains a "sprung" tube into which the tube B slides, carrying the optical part C (a 2-inch in the figure) at its lower end. All the objectives are composed of the sliding-tube B and the optical part C, which together form one piece about the usual size of an objective. In use, the adapter A is kept screwed to the body of the instrument, and the removal of B C from A is effected by simple withdrawal, as in the case of an eye-piece, and another power can thus be readily substituted.

Fig. 118.




For the convenience of those who have objectives with the Society screw, the lower end of the compound body of the Microscope is screwed to the standard size, so that by simply unscrewing the adapter which receives the objectives belonging to the instrument, any standard glass may be used. On the other hand, by sliding any of the former objectives into the adapter when thus unscrewed, they may be used on any other standard instrument. The Society screw has not been adopted for the optical part (joining C to B), which, however, it would be advantageous to adopt if it can be done without increasing the weight to such an extent that the latter would slip down out of the adapter. With the Society gauge, any objectives might of course be applied. At present, the use of the sliding arrangement is confined to the maker's own objectives.

Instead of the "sprung" tube, the plan adopted by Mr. Browning for astronomical eye-pieces might, we think, be made use of with advantage, viz. to make the sliding tube B not cylindrical, but tapering, the "taper" being for a short distance below the middle less rapid than at the middle part, the portion next the collar being exactly cylindrical.

**Homogeneous-immersion Objectives for the Binocular.**—Fig. 119 shows in natural size a $\frac{1}{12}$ homogeneous-immersion objective of Powell and Lealand made as described by Mr. H. Gibbes at p. 373, for use with the ordinary Wenham binocular, and showing both fields fully illuminated.

The lenses of the objective are contained within the lower part of B, the upper portion of *B* being a very short adapter into which the former can be screwed from behind. The back lens is thus brought to within about a quarter of an inch of the binocular prism. As the objective is so much shortened it is necessary with most Microscopes to have either a super-stage or a special arrangement for allowing the tube to be racked down that the objective may focus upon the object on the ordinary stage.

When not required for use with the Binocular prism the lenses are screwed to the long adapter A.

Mr. Wenham many years ago suggested the use of a very small binocular prism with high-power objectives. The prism was mounted in a special tube and was slipped down the body of the objective almost to touch the back lens. Fig. 120 shows (natural size) an $\frac{1}{8}$ objective (with correction-adjustment) constructed by Messrs. Powell and Lealand on Mr. Wenham's plan, D being the objective complete, and C the tube with the binocular prism. The objective, as will be seen, is shorter than usual.

Fig. 119.

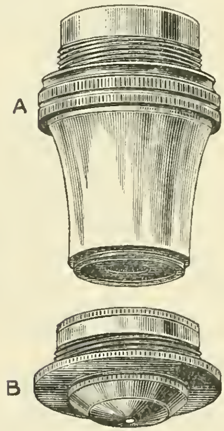
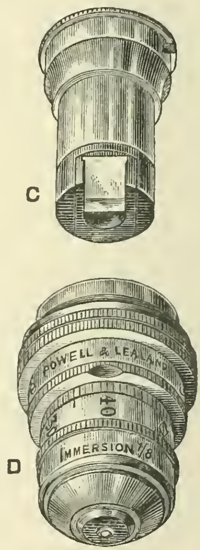



Fig. 120.




The plan first described can be used more effectively with homogeneous-immersion objectives, as they do not necessarily require correction-adjustment. The body can therefore be much shorter and the back lens almost in contact with the binocular prism.

**Extra Front Lenses to Homogeneous-immersion Objectives.**—It is suggested * that if such an objective as Powell and Lealand's new formula homogeneous-immersion $\frac{1}{12}$ † (aperture = 142° in crown glass of index 1·5 nearly, by means of a front lens greater than a hemisphere), were provided with two extra front lenses, one giving an aperture in glass of, say, 115° and one giving 90°, we should be enabled to view objects through a considerable range of thickness of covering-glass, approaching in each case to the maximum aperture that could be used, and hence, probably, we should find much less need of $\frac{1}{8}$ or $\frac{1}{16}$ objectives.

By the homogeneous-immersion formula adopted by Powell and Lealand the focal distance is practically a constant quantity; it

* 'Eng. Mech.,' xxxii. (1880) p. 84. † See this Journal, *ante*, p. 886.

follows then that a reduction of the aperture by making the front lens *thinner* immediately provides greater working distance without affecting the aberrations, for as the *first* refraction takes place at the posterior (curved) surface of the front lens the removal of any portion of thickness at the anterior (plane) surface simply cuts off zones of peripheral rays without altering the distance—the distance being at once filled up by the homogeneous-immersion fluid or by an extra thickness of covering-glass. An extra front lens may then be applied to the back combinations of such a $\frac{1}{12}$ to enable the observer to view an object through a covering-glass that would be practically a maximum thickness for an $\frac{1}{8}$ (aperture = 90°) constructed on the usual formula where the setting encroaches on the active spherical refracting surface; a second front might give a high average aperture for a $\frac{1}{12}$ (115°), whilst the thickest front (representing the maximum aperture of the whole construction, 142°) enables the observer to view an object with a *greater* aperture than has hitherto been obtained with any $\frac{1}{16}$, owing to the difficulties of construction, and through a thicker covering-glass than a $\frac{1}{16}$ of this aperture (even if it could be successfully made) would permit of; hence the three different fronts would give a great range of aperture with a corresponding range of working distance, which is practically what is sought by having objectives constructed of the three different foci, $\frac{1}{8}$, $\frac{1}{12}$, and $\frac{1}{16}$.

We understand from Messrs. Powell and Lealand that for an aperture of 115° in glass, there would be no necessity to mount the front lens on a plate, that aperture having already been successfully obtained and exceeded by mounting the front in the usual way. The purpose of the plate (which is only ·003 in. thick) is, as before mentioned,* to allow of a portion of the posterior curved refracting surface of the front lens *beyond* the hemisphere to be utilized.

**Fluid for Homogeneous-immersion Objectives.**—Mr. A. A. Bragdon writes to us in regard to his note inserted at page 701. After referring to the fact that sulpho-carbolate of zinc was first suggested by Professor Abbe,† he says that cedarwood oil, in his opinion, can never become generally useful. It varies so much in different samples that even an index of 1·512 as first named for it cannot be relied upon. Then it is so fluid that it runs all over slide and stand, so that the objective cannot be immersed without placing the Microscope erect every time. Experimenting with it, however, in combination with other oils, some good results were obtained, e. g. with oil of anise, although not equal to the zinc and glycerine, which can be as easily cleaned from the slide and lens as glycerine by using water.

By taking equal parts by weight of C. P. glycerine (Price's) and sulpho-carbolate of zinc crystals, mingling the two, and applying heat sufficient to boil the glycerine, a solution of proper index can be obtained for use with a Zeiss objective of 1·50 index, or a Tolles of 1·525 index (i. e. for all practical purposes). If, however, one desires to be exact for the latter, the solution will have to be evaporated

* See this Journal, *ante*, pp. 884–5. † Ibid., ii. (1879) pp. 346 and 823.

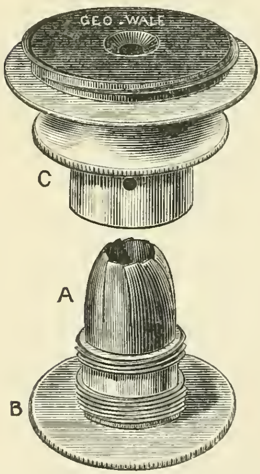
somewhat, or more carbolate added. The solution can be made in about one hour.

No fear need be had about boiling too long, as the longer this is done the less liability will there be for the solution to deposit crystals on the bottom of the bottle when cooled, which it will do if the temperature is only kept up long enough to first dissolve the crystals. Some made in October 1879 is still free from any deposit. Filter while hot, and the microscopist will have a solution practically of *fluid crown glass* as clear and transparent as glycerine itself, having only one objection, viz. when of 1·50 to 1·525 index, the consistency is such that if used on a histological preparation *just* mounted and the objective racked back to remove the slide, the cover, unless great care is used, will be lifted enough to endanger a choice preparation.

Mr. Bragdon is still experimenting with the view of finding a medium a trifle more fluid so as to make the homogeneous-immersion objectives "as nearly perfect as possible for every-day use."

**Iris Diaphragms.**—To the "Working Microscope" of G. Wale * an inexpensive and very simple and ingenious form of "iris" is adapted, shown (separated) in Fig. 121. It consists of a piece of very thin cylindrical tube A, about $\frac{3}{4}$ inch in length and $\frac{5}{8}$ in. diameter, the whole circumference of which is cut through with shears to nearly its whole length at intervals of about $\frac{1}{4}$ inch; by means of a screw-collar B, attached below, this cut tube is forced into a parabolic metal shell (contained within C) whose apex is truncated to an aperture of about $\frac{3}{8}$ inch; the pressure of the screw causes the thin metal tongues to turn and to overlap in a spiral which gradually diminishes the aperture to the size of a pin-hole. On unscrewing the collar B, the spiral overlapping of the tongues is released somewhat, and their elasticity causes the aperture gradually to expand.

Fig. 121.




As adapted to the stage of the "Working Microscope," the iris, when unscrewed until its aperture is smallest, is then almost in contact with the base of the slide; when at its largest expansion it is about $\frac{1}{16}$ inch lower. The whole device is fitted into the opening of the stage from beneath (so as to be flush with the upper surface) with one turn of a very coarse screw on the edge of C—a far more convenient plan than the "bayonet joint."

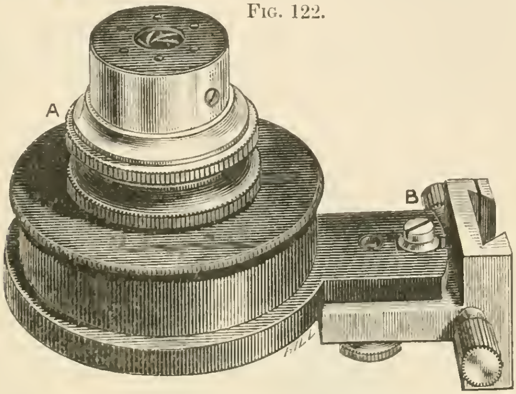
Another form of "iris" (Fig. 122) has been manufactured in America by Messrs. Sidle and Poalk (fitting to their "Acme" stand).† It is similar in construction to the earlier forms known

* See *ante*, p. 1045.

† See this Journal, *ante*, p. 522.

in England, but instead of the movement of the plates being controlled by a lever arm, there is an outer cylinder-cap A, that can be turned like the adjusting collar of an objective. The range of aperture is from about $\frac{3}{8}$ inch to a pin-hole, and it remains

Fig. 122.




in the same plane during the motion. This diaphragm is mounted on a substage B provided with centering motions (a short bar working with a loosely fitting slot, that can be clamped beneath), which is a somewhat primitive contrivance. Centering motions must be capable of exact adjustment or they are practically useless.

**Swift's Calotte Diaphragms.**—Messrs. Swift have recently devised two forms of "calotte" diaphragms for use *above* the achromatic condenser, and on a level with the plane of the object stage.

Fig. 123.

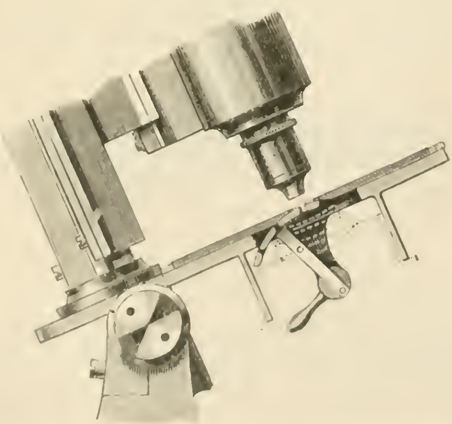
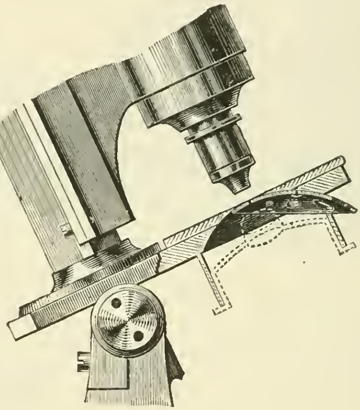


Fig. 123 shows the first method. A small rectangular segment of a spherical shell has three different sized diaphragms cut, and the mounting is so contrived that by movement of the lever-arm (shown with shaped handle attached), the diaphragms can be successively moved over the achromatic condenser, the optical part of which is shown by dotted lines. The stage is suitably hollowed out beneath to facilitate the adjustment.

Fig. 124 shows an improved form, which Messrs. Swift regard as superseding that shown in Fig. 123. The diaphragms are here cut in

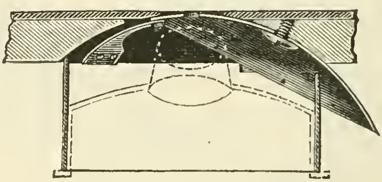
Fig. 124.



a metal "calotte" mounted eccentrically, so that by rotation the apertures pass successively over the top of the achromatic condenser; the rotation is effected by the projecting edge of the calotte—somewhat as with the diaphragms in Gillett's condenser.

It should be observed that Mr. Zeiss has for some time applied calotte diaphragms to his "Travelling Microscope"; * but they do not

Fig. 125.



act quite in the plane of the stage, nor are they constructed to be used in conjunction with the achromatic condenser. It is evident, however, that the effect obtained is similar to Mr. Bulloch's application of the Gillett diaphragm *above* the condenser.† In Messrs. Swift's

* See this Journal, ii. (1879) p. 955. † *Post*, p. 1078.

arrangement (as shown on a larger scale in Fig. 125) the calotte is attached to the under surface of the stage,—in Mr. Bulloch's plan, the diaphragm plate forms part of the condenser and can thus be removed at pleasure.

**Swinging Substages.**—As there seems to be a tendency to provide Microscopes which have a substage with the so-called "swinging" form, we now extend the history of such instruments by giving descriptions in the succeeding notes of some which we have not yet described.

Taken in chronological order, the instruments hitherto made with such substages are as follows:—

| | | |
|---|---|---|
| GRUBB | 1853–8 | See vol. ii. p. 320, and below. |
| THURY-NACHET | 1855 | „ *post*, p. 1059. |
| ROYSTON-PIGOTT | 1862–4 | „ *post*, p. 1060. |
| TOLLES | 1871 | „ *post*, p. 1061. |
| BULLOCH | 1873 | „ *post*, p. 1067. |
| ZENTMAYER AND ROSS-ZENTMAYER | 1876–80 | „ vol. i. p. 197, vol. ii. p. 320, and *ante*, p. 704, and *post*, p. 1067. |
| TOLLES-BLACKHAM | 1877 | „ vol. i. p. 392, and *ante*, p. 520. |
| BULLOCH | 1877 | „ *post*, p. 1073. |
| SIDLE AND POALK | 1880 | „ *ante*, p. 522. |
| BECK | 1880 | „ *ante*, p. 329. |
| SWIFT | 1880 | „ *ante*, p. 867. |

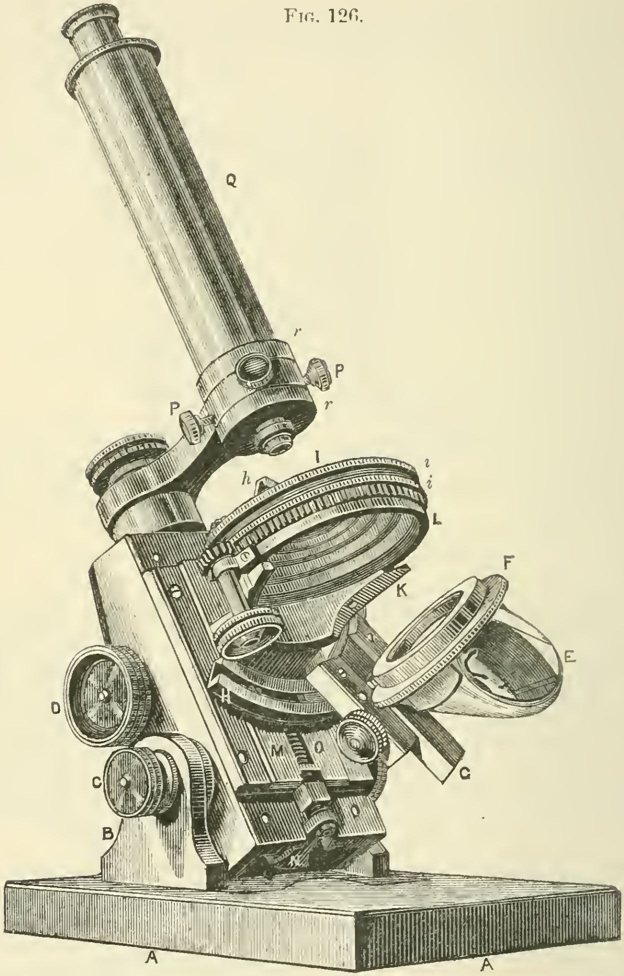
**Grubb's Sector Microscope.**—This is admittedly the earliest instrument of the kind referred to in the preceding note. The following description is contained in a paper read on the 26th March, 1858, to the Royal Dublin Society,* and is entitled "On a New Table Microscope, by Thomas Grubb, Engineer to the Bank of Ireland":—

"The instrument to which I have the honour of drawing your attention this evening will be recognized by some present as having the same general and peculiar form of that which I had devised and constructed some years since, and previous to our (Dublin) Microscopic Society having merged into the 'Natural History' Society.

"The instrument, in its original state, included, indeed, the advantages of extreme steadiness, an improved fine adjustment for focussing, and improved safety-tube for the object-glass, with the means of viewing objects (placed on a horizontal stage) at the most comfortable angle for vision. But it is the peculiarity of the instrument, in its present state, that it removes all necessity for that subsidiary and costly apparatus for illumination which those microscopists who pursue delicate microscopic research find it necessary to provide, in addition to the Microscope *proper*; and not only this, but the present instrument enables the observer to apply, with a facility otherwise unattainable, without removing the eye from the instrument, without any changing of parts, and by simply moving its one illuminator on its sector, every kind of illumination, *seriatim*, to an object placed

* 'Journ. R. Dublin Soc.,' 1858; reproduced in 'Engl. Mech.,' xxxi. (1880) p. 229.

Fig. 126.




A A. The base (of mahogany).

B. One of the two brackets of support.

C. One of the two milled heads for clamping the instrument at the desired inclination for use.

D. One of the milled heads for coarse adjustment of focus, acting upon a strong triangular-bar (not seen in the engraving).

E. Illuminating prism.

F. Milled ring for adjusting by hand the *azimuth* of the prism.

G. Slide, with rack and pinion, for adjusting the distance of the prism from the object.

H. Sector (seen also at *h*) on which the prism is moved by hand through any required arc concentric with the object on the stage.

I. The stage; *i i*, upper and lower milled rings, which produce, on being turned by hand, the slow motions, in two directions, of the object-plate of the stage.

K. Bracket-piece supporting the stage, and also the plate for carrying the polarizer when required.

L. Toothed wheel with pinion and milled nut for revolving the stage in azimuth.

M. Dovetailed slide carrying both stage and sector, with the illuminating prism. A screw and its bent lever (the latter passing to the back of the instrument) are partially seen at N; and at O is a spiral spring which keeps the slide M in close contact with the screw N. The lever N is equally available to either hand at the back of the instrument; P P are opposing screws which serve to bring the optic axis of the body or tube Q to coincide with the centre of revolution of the stage, Q being purposely not screwed (as usually) into the projecting arm, but held (with a sufficient amount of lateral movement) between the collars *r r*.

upon the stage of the instrument. It does more than this; for it enables the observer, when he has produced any appearance or effect by the illumination which he desires to reproduce at pleasure, to register the same, so that he can either resort with certainty to it at a future time, or communicate the particulars to a friend, who, if possessed of a similar instrument, can do likewise.

"The subsidiary apparatus for illumination of a well-furnished Microscope usually includes a set of achromatic condensers, the prism of Amici, the parabola of Shadbolt, and Bergin's addition to the latter for oblique illumination. It is unnecessary to go into any detail of the trouble experienced, and the time frequently consumed in obtaining, with the assistance of one or more of these appliances, a satisfactory illumination. These drawbacks are well known to microscopists. For the information of others, I may state that frequently five minutes of very eye-teasing work, and sometimes three times that, are devoted to obtaining a satisfactory result, which, after all, is liable to be undone by an incautious touch of the mounting, and which is only to be restored by the same tentative process of the previous adjustment.

"It was such experiences as these which led to the improvements combined in the present instrument. A little consideration was sufficient to show that, assuming we are in possession of an illuminating pencil of unexceptional quality for every kind of illumination required, then every kind of such, including the illumination of opaque objects, will be comprehended under two heads, viz. first, the means of applying such illuminating pencil at all angles with respect to the plane of the object (or the stage of the Microscope); secondly, the means of applying the pencil at all azimuths of same.

"This generalization, so to speak, of the illumination indicated the means of carrying it out effectually. I had previously ascertained, from direct use, that an achromatized prism was capable of giving every kind of illumination required, in a manner not surpassed by other means extant. Rejecting the difficult matter of causing the illuminating pencil to move in azimuth round the object, I devised the present stage, which, while it is made to revolve, has those objections to revolving which appertain to other stages removed; and, by making a little variation in the manner of attaching the body (or tube) of the instrument to its arm, means are provided for readily bringing the optic axis of this tube to pass through the centre of revolution of the stage, and thus all objection to revolving the object, instead of the light, is got rid of.

"For the other movement of the prism (or that vertical to the plane of the stage), I have, as may be seen, adopted a sector, on which slides the carriage containing the prism and including the ordinary adjustment for focussing and a small azimuthal movement for modifying the illumination. This sector is attached to the same piece which carries the stage, and so that its centre, if produced, would cut the optic axis of the tube where an object mounted upon a glass slide of the ordinary thickness and laid upon the stage of the instrument would be. A prism or other object being simply moved round on a sector so placed, will evidently remain unchanged in its distance from that central point.

"In constructing the illuminating prism, it was to be recollected that there was but one direction in which the light could be placed, viz. in the plane of the object, or say one-tenth of an inch above the plane of the stage, and vertically to the sector's plane; and, secondly, that the distance of the light from the stage must be assumed. The prism, therefore, necessarily reflects the rays at a greater angle than 90°, and its reflecting surface usually requires silvering. This has been assumed to be an objection; but the light is still more than ample, as well as beyond that given by most other illuminators, the prism having (although a triple combination) only two uncemented surfaces. I have, from my own experience, adopted a distance for the source of light of about 15 inches, as most useful for general work; but should a distance of 2 feet or upwards be selected, then the prism may be one of total reflection and its reflecting surface consequently remain unsilvered.

"The manner of using the instrument is, shortly, as follows:—The microscopist will, of course, place it as he would any other Microscope, conveniently on a table, and incline it to the desired angle for work. The lamp, or other source of light, is to be placed directly opposite, and in front of, the instrument, and at the proper distance of height, the distance being always the same, and the height that which brings the light into the plane of the upper plate of the stage. The adjustment may be verified and corrected as follows:—Place a slider with a grayed surface on the stage (grayed surface upwards); move the prism to the lowest point of the sector (or to zero), and turn it directly outwards, or towards the light; adjust the distance of the prism from the grayed surface, so that an image of the light is formed upon the latter; and looking through the tube of the instrument (the lenses being removed), observe if the image formed on the grayed glass be central with the tube; if not, make it so by a slight alteration in the inclination or azimuth of the instrument, without varying its distance from the light. It is by no means necessary to make these adjustments accurately; but the more accurate they are, the more perfectly will the image on the grayed surface *only revolve*, and without changing place, on moving the prism on the sector. It is, perhaps, unnecessary to observe that the Microscope, without making any of these adjustments, may be used in the same manner as, and with all the convenience of, an ordinary instrument, while, by making the adjustments as described, we obtain the peculiar advantages sought for in the construction.

"These advantages may be shortly summed up as follows:—An object being placed upon the stage, and the focus adjusted, the observer can examine it under every azimuth of illumination by revolving the stage, and under every possible kind of illumination in each azimuth, viz. direct transmitted light, oblique transmitted, dark-ground illumination, and, finally, the illumination for opaque objects, by simply moving the prism on the sector; and he can do all this without once removing his eye from the eye-piece; while the quality of the illumination, in all its varieties, is such as is not surpassed by other more or less special contrivances. Indeed, the general impression of those who have used the instrument is that its illumination is more effective, particularly in showing the delicate details of difficult objects, than any other extant.

"Lastly, and not least, the power of reading off on the sector the angle of illumination used, whereby the effects of different angles of illumination can be registered, resorted to again at pleasure with certainty, or communicated to other observers, enabling them to do the same, if provided with a similar instrument.

"Perhaps I may be permitted to conclude this imperfect description by mentioning what one who is well qualified to judge of the merits of the instrument has communicated respecting it. He quaintly says, 'I find but one fault with your Microscope, and that is, that it puts me out of conceit with the using of any other.'"

Although the above paper is dated 1858, it should be noted* that the main features of novelty had been previously described by Mr. Grubb, viz. in 1853, in the 'Proceedings' of the Royal Irish Academy,† and in his patent of 1854, ‡ in both of which the graduated sectoral arc is referred to. In the paper of 1853 Mr. Grubb said he had mounted "a suitable illuminator on a vertical circular sector (nearly a complete circumference), concentric with the focus; this part of the arrangement enables me to throw the beam on the object at all angles of incidence, whether from beneath, as in the case of translucent, or from above, in the case of opaque objects, and as the sector is graduated, I have the power of observing or restoring any position at pleasure."

**Thury-Nachet Traverse Substage.**—This appears to be the next in order of date, having been made by M. Nachet, on the suggestion of M. Thury, in April 1855.

The substage is shown in Fig. 127, separated from the Microscope. It consists of two sector-bars C C equidistant from the object, mounted parallel and attached to the main limb of the stand by screws behind the square end G. These bars carry the condenser B above, and the mirror A below, on a moving framework on which is a graduated scale F for observing the degree of inclination. By means of a rack and pinion (milled head D shown on the further side of figure) the framework, carrying condenser and mirror, can be moved concentrically with the object, producing oblique illumination. The traversing movement causes the toothed pinion H to turn in the rack J, and an endless screw at the lower end of the same pinion (behind the milled head E) works on the toothed wheel I attached to the mirror; this automatic motion keeps the reflected beam from the surface of the mirror exactly in the axis of the condenser whilst the latter is being inclined obliquely to the object. The mirror itself can be adjusted by the milled head E, the pinion through I being held in position by

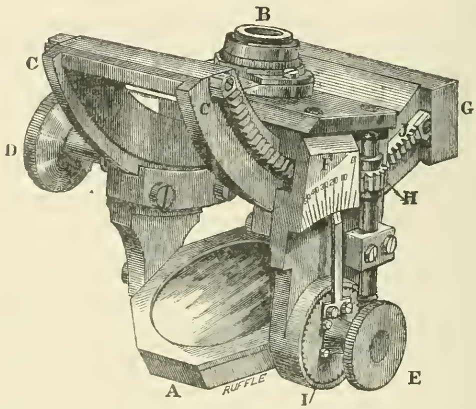
* 'Engl. Mech.,' xxxi. (1880). † Vol. v.

‡ See this Journal, ii. (1879) p. 320.

friction. An indicator arm on I marks the degree of inclination on the scale at F.

If we suppose the apparatus, as figured, to be in adjustment for central light, then, by turning the milled head D, obliquity of

Fig. 127.




incident light is obtained as far as the rack on the sector-bar or the thickness of the stage will permit, the surface of the mirror inclining regularly so that the reflected light is directed constantly in the axis of the condenser throughout the traversing movement.

The original apparatus from which Fig. 127 was drawn was at once forwarded to us by M. Nachet upon our applying for information on the subject, and at the same time he wrote: "The apparatus was specially designed to keep the focus of the illumination upon the object with varying degrees of oblique incidence. The movement was, however, only from back to front—not lateral. In Grubb's and more modern stands, lateral movement of the substage (unless the lamp be attached to the moving arm) necessitates a continual readjustment of the mirror or reflector; whereas in this device the mirror moves automatically with an exactly calculated differential motion, and the light is constantly directed in the axis of the condenser, consequently in the field of view, whatever may be the inclination. The observer can thus watch the minutest changes developed by the obliquity, which appears to me a considerable advantage."

**Royston-Pigott's Oblique Condenser Apparatus.**—Dr. Royston-Pigott is the inventor of an apparatus for giving oscillating oblique action to the condenser. It was thus described * by him:—

"In former times the precise position of the mirror for throwing the rays of reflected light at one particular angle (often hit only with much waste of time and labour) was attained with more or less success so as to give the most brilliant definition of

* 'Mon. Micr. Journ.,' xvi. (1876) p. 178.

difficult objects. In 1862 I adapted a semicircular arc carrying a condenser, and afterwards I constructed gimbals to carry an achromatic condenser at any angle of obliquity, attached to a double-motion stage placed exactly beneath the upper stage movements: by this contrivance particular angles of illumination could be readily attained without the excessive aberration of the usual wide-angled achromatic condenser. The instrument is exhibited in the South Kensington Museum Collection, No. 3551—described as follows:—'3551. Microscope with complex adjustments, searcher, and oblique condenser apparatus. This Microscope is fitted with a peculiar hypocycloidal movement and traversing screws for very delicate observations. The condenser possesses wide rectangular movements combined with a unique oscillatory oblique action for directing the minute image of a flame or of the sun either directly or obliquely upon any desired point in the field of view, giving fine views of many difficult objects. . . . .'"

**Tolles' "Radial Arm" and "Circular Track" Microscopes.**— Our information in regard to these Microscopes is derived from certain sworn depositions which have been forwarded to us, and which we print verbatim.

"*Invention of Swinging Substage.*

WASHINGTON CITY, DISTRICT OF COLUMBIA, SS.

I, J. J. WOODWARD, a Surgeon in the United States Army, and a resident of the city and district aforesaid, do hereby solemnly swear that Mr. R. B. Tolles, of Boston, visited me at the Army Medical Museum, Washington, District of Columbia, June 30, 1871; that he had with him several objectives and a small Microscope-stand fitted with a radial arm beneath the stage, carrying a condensing lens of about one inch focal length, and so arranged that by deflecting the arm, any degree of obliquity in the illumination could be obtained; and that I was so pleased with the contrivance that, November 8, 1872, having occasion to inquire of Mr. Tolles the price at which he would make a large stand for the Museum, I made it a condition in a letter written on that day, that the stand should have a 'radial arm to carry an inch condensing lens for oblique light.'

J. J. WOODWARD,
*Surgeon U.S. Army.*

Sworn to and subscribed before me this eighteenth day of September, A.D. 1880.

LOUIS SCHADE,
*Notary Public.*

I, EDWARD W. MORLEY, of Hudson, in the State of Ohio, Professor of Chemistry and Toxicology in Cleveland College, and Professor of Chemistry in Western Reserve College, on oath depose and say that on the seventh or eighth day of August, 1872, I was in Boston, in the

State of Massachusetts, and there selected a Microscope objective at the office of Charles Stodder, agent for Robert B. Tolles, of said Boston. Afterward on the same day I met said Tolles, the maker of said objective in his manufactory on Hanover Street in said Boston, and conversed with him about the manipulation of said objective. In said conversation said Tolles described a device for facilitating the application of light of any desired obliquity, which device he thought would be possibly the best for my purpose. It was to attach to the stand of the Microscope an arm which would rotate on an axis at the level of the upper surface of the object-slide. To this arm an achromatic condenser (or objective as a condenser) could be screwed so that if adjusted to bring light to a focus on the object at any one obliquity it would still be in focus at any other obliquity. Said Tolles exhibited to me a device used by him on his own stand to accomplish this result. It consisted of an arm under the stage carrying the achromatic condenser, which arm was adapted to carry the condenser through a considerable arc, keeping it in a radial position with the centre of motion at the focus of the objective in use in the body. We discussed several plans for securing the motion around the plane of the upper surface of the object. I understood that the plan used in said Tolles' stand was an adaptation of a stage not originally designed for the purpose and therefore of necessity the radial motion with centre in the plane of the object was obtained by some combinations whose nature does not occur to me. My recollections about the radial arm for oblique light from a condenser as seen by me at this time are very distinct because I had then some intentions of imitating the arrangement and actually afterwards made some preliminary trials in that direction. In reference to my own Microscope-stand, said Tolles, in said conversations suggested the making of a semicircular track to be borne on the substage fitting, which should answer the same purpose of carrying the condenser concentrically with the object on the stage.

EDWARD W. MORLEY.

STATE OF OHIO, SUMMIT COUNTY, SS.

Sworn to by the said EDWARD W. MORLEY, before me, a Notary Public, within, and for said County and State, and by him subscribed in my presence this 23d day of May, A.D. 1878.

Witness my hand and official seal at Hudson County and State aforesaid this 23d day of May, 1878.

H. B. FOSTER,
*Notary Public.*

I, ORLANDO AMES, of Somerville, in the Commonwealth of Massachusetts, on oath depose and say, that in the years 1870, '71, and '72, in the shop of the Boston Optical Works, of which Mr. R. B. Tolles was Superintendent, I had charge of the work of construction of Microscope-stands. That in the years 1870 and 1871 the first Microscope-stand of his class A was made. That after it was otherwise completed, I by Mr. Tolles' direction adapted to the stand a swinging arm to carry a condenser at various obliquities to the optical axis of the

Microscope.* This arm was hinged to have its axis of rotation as nearly in a line passing through the object place on the stage as was conveniently practicable. The stage having mechanical movements was of considerable thickness and the axis of the arm was therefore fixed at a point about three-fourths of an inch below the place of the object. The arm swung over an arc of a circle graduated to read angles of obliquity of the arm, and the condenser had an independent motion of its own so that its axis could always be brought to coincide with a line passing through the object on the stage. That at this time and for an indefinite period before, I had known of such an arrangement of swinging arm on a Microscope used by Mr. Tolles particularly for trial and testing of objectives. In this case the whole arrangement could be attached to the main arm of the Microscope and detached readily. The axis of motion of the arm was under the stage, but the whole apparatus had adjustment laterally (or sidewise) so that the swinging arm could be brought into line with any radius of the object as a centre through a considerable range of obliquities. That in the summer of 1875, I, by Mr. Tolles' direction constructed and adapted to a Microscope-stand of his class B, numbered [ ] and now belonging to Dr. J. Bacon of this city a *circular track* as a substitute for a *radial arm.* That this circular track having its centre coincident with the object place on the stage involved no change in the model or construction of the B stand, whereas the incorporation of a radial arm required considerable change; and I desire to distinctly state that the circular track was adopted for that instrument instead of the swinging radial arm to avoid such change and reconstruction.

I have also to state that during the period named, from 1871 to 1875, the plan as an invention of Mr. Tolles of a swinging radial arm for condenser, and other accessories of a Microscope having its axis of motion in the object or object-place on the stage was familiarly known and talked of in the shop where his Microscopes were made. ORLANDO AMES.

Witness, F. L. HAYES.

SUFFOLK, ss. Boston, March 19, 1878.

There personally appeared the above named ORLANDO AMES and made oath that the foregoing statement, by him subscribed, is true.

Before me, FRANCIS L. HAYES,

*Justice of the Peace.*"

In July 1875, Mr. Tolles made and sold the instrument described in the following specification for a patent (the application for which was filed in July 1877 †):—

---

* NOTE.

"TOLLES' LARGEST MICROSCOPE.

A.

* * * * * * * Can be furnished with radial arm to carry accessory apparatus at any angle for $50."

—C. Stodder's Price List for 1872, page 5.

† According to the U.S. Patent Law, an inventor has two years *after* the first instrument is sold in which to apply for a patent.

## United States Patent Office.

### Robert B. Tolles, of Boston, Massachusetts.

*Improvement in Microscopes.*

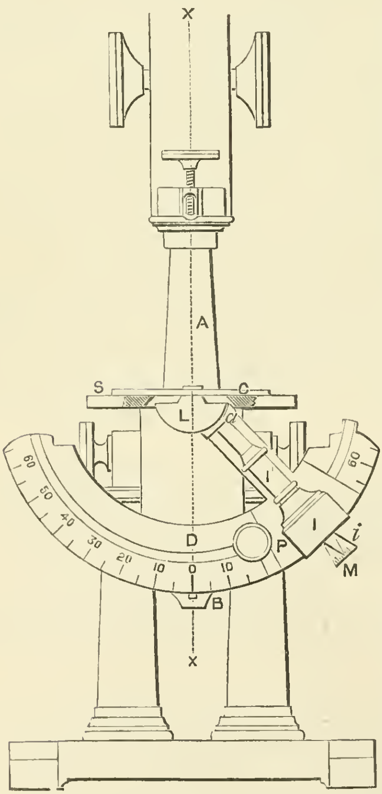
Specification forming part of Letters Patent No. 198,782, dated January 1, 1878; application filed July 27, 1877.

*To all whom it may concern:*

Be it known that I, Robert B. Tolles, of Boston, in the County of Suffolk and State of Massachusetts, have invented certain new and useful improvements in Microscopes, of which the following is a specification, reference being had to the accompanying drawings, making a part of the same, in which—

Figure 128 represents a front elevation of a portion of a Microscope-stand with my improvements applied thereto. Fig. 129 represents a side elevation of the same. Fig. 130 represents in section a portion of the substage detached. Fig. 131 represents in side elevation a portion of the substage illumination apparatus detached and drawn upon an enlarged scale, and modified by connecting with it a graduated arc; and Fig. 132 represents in end elevation the parts shown in Fig. 131.

Fig. 128.




My invention relates to the combination of a circular track in a plane parallel with the optical axis of the instrument and concentric with the object to be examined, with a substage carriage, upon which said track is mounted and carried on guides.

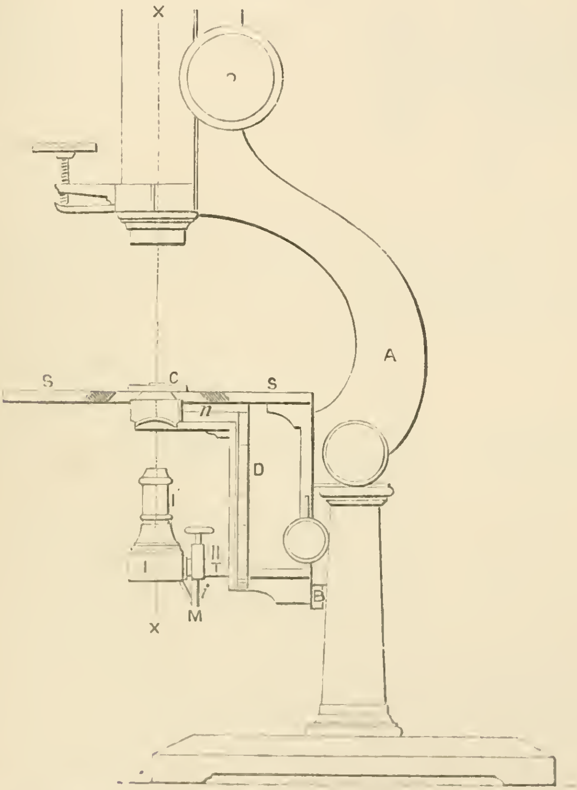
It also relates to the said circular track, provided with graduations, in combination with a carriage running thereon, and carrying a condensing-lens and other accessories, either singly or combined.

It also relates to a holder to carry an achromatic illuminator or other accessory, in combination with a graduated arc and clamping device, to fix the holder at any angle to the radius that may be desired, or in the radius of the circular track.

It also relates to a convex lens, either plano-spherical or plano-cylindrical, in combination with a plano-concave lens, that can be caused to traverse the surface of the plano-convex lens, and an illumination-tube to direct a beam of light through the plano-concave lens.

It also relates to the convex lens and its support in the radius of the circular track, in combination with an illuminating device.

Fig. 129.




It also relates to a graduated circular track to support an illumination-tube and accessories, with the stage, to support the object-slide, as will be more fully described hereinafter.

In the drawings, the base or stand has jointed to it a curved arm A, upon which the body of the instrument is mounted. It also carries the stage S, upon which is placed the object-slide C. D represents a circular track mounted upon a substage carriage B, connected to the arm A. This circular track is mounted and carried on or within guides in a plane parallel to the optical axis X X of the instrument and concentric with the object to be examined, mounted in the slide C, so that whether the slide be above or below the stage, the object it holds shall always be in the axis of said circular track D. This track has graduation-marks placed upon it, by which the position of the carriage P, that it carries, can be set and recorded. It may also be

FIG. 130.

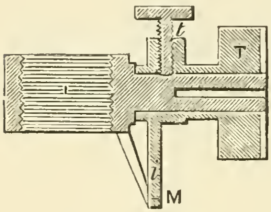
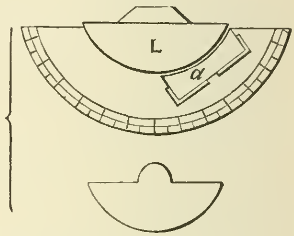


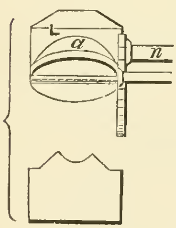

FIG. 131.




used without graduations. Upon this carriage is mounted the substage T, carrying the holder I, to which is screwed the illumination-tube I′, or other accessories.

The spindle of the holder I can turn in its socket, and be clamped to it by the screw *t* in any position in which it may be placed, to carry an achromatic illuminator or other accessory, either in the radius of the track D, or at any degree of obliquity thereto; and to facilitate this adjustment, it is provided with an index M, resting against a graduated arc *i*, attached to the substage.

FIG. 132.




The apparatus is provided with a convex lens L, either plano-spherical or plano-cylindrical (the plane surface of either being modified to concave or convex, if either of these forms should for special purposes be deemed preferable to a plane), and a plano-concave lens *a*, the curvature of whose concave surface is the counterpart of the convex surface of the lens L, the lens *a* being caused to traverse the surface of the lens L by the movements of its carriage—in this instance an arm of the carriage P, which latter also carries an illumination-tube I′, or a condenser arranged to direct a beam or pencil of light upon the plane face of the lens *a*. The convex lens L is mounted upon the axial end of an arm *n*, which arm is in the radius of the circular track D, and is also carried by the substage.

Having now fully described my invention, I claim—

1. The combination of a circular track D in a plane parallel to the optical axis X X of the instrument and coincident with the object to be examined, with a substage carriage B, upon which said track is mounted in a plane parallel to the optical axis, substantially as shown and described.

2. The combination of a graduated circular track D, with a

carriage P running therein, and carrying a condensing-lens and other accessories, either singly or combined, substantially as shown and described.

3. A turning-holder I, carrying an index M, in combination with a graduated arc *i*, and a clamping device, to secure the holder either in the radius of the track D or at any degree of obliquity in which it may be placed, to carry an achromatic illuminator or other accessory, substantially as shown and described.

4. The combination of a convex lens L, of plano-spherical or suitable form, with a plano-concave lens *a*, of counterpart curvature, and a carriage P carrying said concave lens, and also an illumination-tube, substantially as shown and described.

5. The combination of a convex lens L, and an arm *n*, on the axial end of which said lens is mounted, with a circular track D, and carriage P, carrying a suitable illumination device, substantially as shown and described.

6. The combination of a graduated circular track D, and carriage P, for guiding and supporting an illumination device and other accessories, with a stage S for supporting the object-slide, substantially as shown and described.

In witness whereof I have hereunto subscribed my name.

ROBERT B. TOLLES.

In presence of—

P. S. YENDELL,
ARTHUR MCNALLY.

**Bulloch's Sector Microscope.**—The next in order of date is the Microscope shown in Fig. 133, which was designed by Mr. W. H. Bulloch, of Chicago, U.S.A., and exhibited in 1873.

The figure shows the general design of the Microscope. The substage was described by Mr. Bulloch as follows: "Compound substage, with the most complete movements for centering or for oblique light, with achromatic condenser, has one-fourth inch movement each way, rack and pinion vertical movement, *rack and pinion movement in arc of circle for oblique light. . .*"

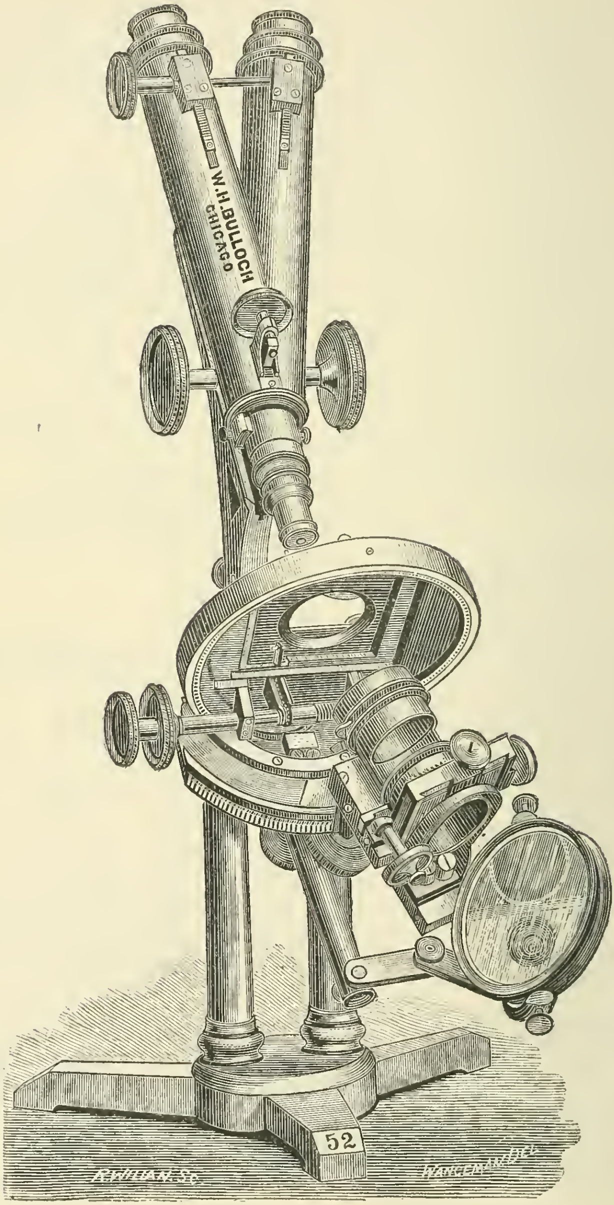
The sectoral arc is shown in the figure just below the stage, as well as the rack and milled head of the pinion by which the substage is moved. The mirror is on a separate bar and can be swung above the stage and clamped by a screw, the milled head of which is seen at the back of the instrument.

**Zentmayer's Centennial and Histological Microscopes.**—(1) *Centennial.*—This Microscope, shown in Fig. 134, was first exhibited at the Academy of Natural Sciences of Philadelphia on April 2, 1876; and then at the Philadelphia Centennial Exhibition in 1876, and subsequently at the Paris Exhibition in 1878.

The following is Mr. Zentmayer's description of it.* "The instrument is 19 inches high when arranged for use. It is mounted on a

* 'Illustrated Price List,' 4th edit.

Fig. 133.




BULLOCH'S SECTOR MICROSCOPE.

broad tripod base with revolving platform, bevelled, silvered, and graduated in degrees for measuring the angular aperture of achromatic objectives. Upon this platform are two pillars, between which the bar and trunnions (which are of one piece) swing for inclining the instrument to any angle.

The *coarse adjustment* is effected by rack and pinion. The *fine adjustment* (in all other instruments of the Jackson principle in front of the body) is removed to the more stable part of the instrument, the bar, which is provided with two slides, one for the rack-and-pinion adjustment, and close to it, another one of nearly the same length, for the fine adjustment, moved by a lever concealed in the bent arm of the bar, and acted upon by a micrometer screw. In this way the body is not touched directly when using the fine adjustment, and the body does not change the relative distance of objective, binocular prism, and eye-piece. (A woodcut of the fine adjustment will be found at p. 321 of vol. ii.)

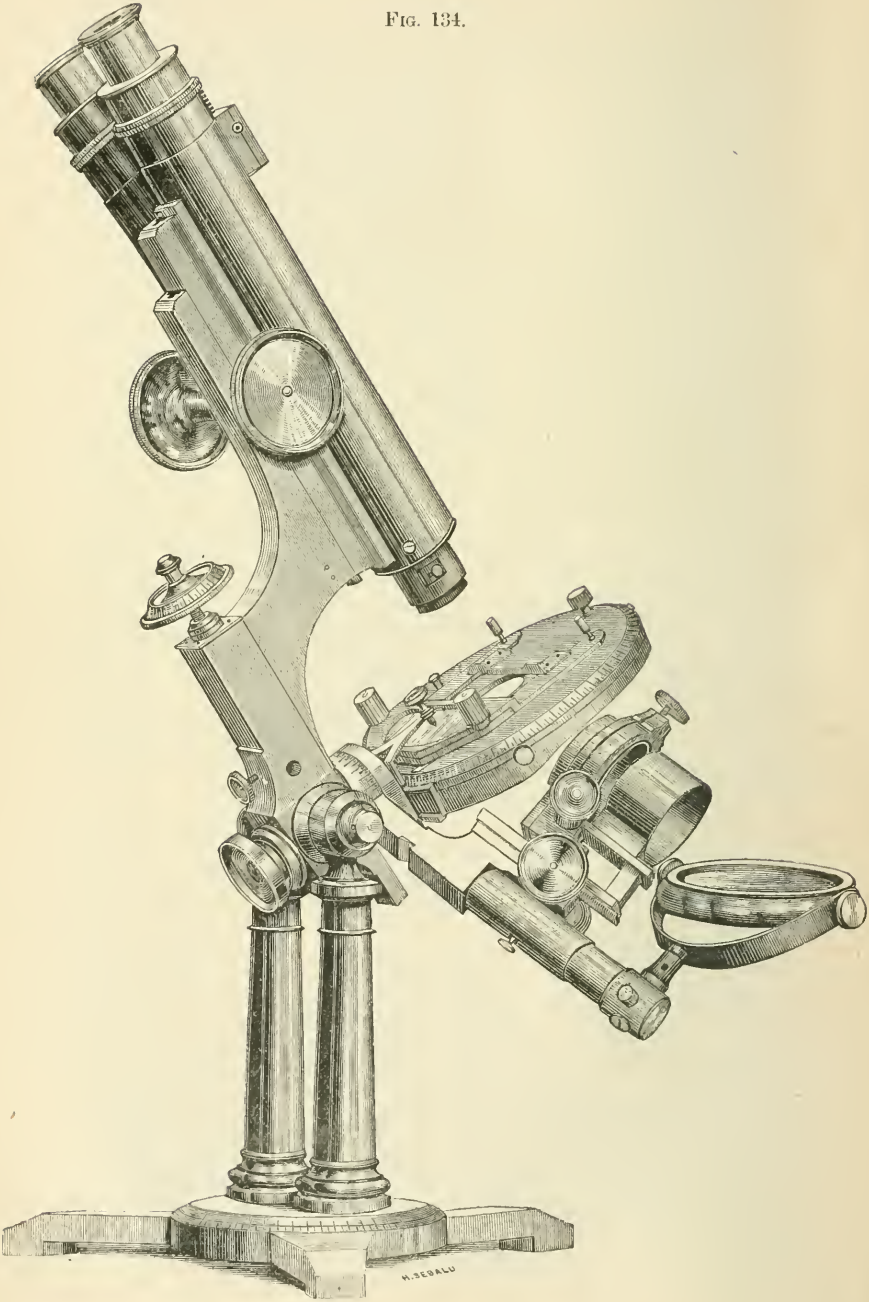
The *swinging substage*, which carries the achromatic condenser or other illuminating apparatus and the mirror, swings around a pivot placed behind the stage, of which the axis passes through the object observed, so that the object is in every position in the focus of the illumination. This most important arrangement, without which no Microscope can be considered complete, is carried out in an extremely simple and substantial manner. Although provided with but a single joint, it admits of being swung over any of the stages; a complete revolution is only interfered with by the body of the instrument. It is provided with a graduated circle at the upper collar for registering the degree of obliquity, and a stop to indicate when it is central with the main body.

The substage is divided into two cylindrical receivers, to facilitate the adaptation of several accessories at one and the same time. The upper cylinder has centering adjustment, the lower cylinder of the two can be moved up and down or entirely removed.

As an object placed on the stage is in a plane with the axis of the trunnions, it is obvious that, if the instrument is placed in a horizontal position, the object is in the axis of revolution of the graduated platform, and the angular aperture of an objective focussed on this object can be easily measured. It can be readily seen that in this position the object is in the centre of all the revolving parts of the instrument, the revolving stage, swinging substage, and the platform."

There are three *Stages:* 1st. One devised by Mr. Zentmayer in 1862 (shown in position on the stand, Fig. 134), which is 5½ inches in diameter and ½ inch in thickness. "It consists of a bell-metal ring, firmly attached to the bar, but adjustable by means of set screws, in order to make it perfectly concentric to the optical axis of the instrument. This ring receives the stage platform, which has a complete revolution. The outer edge is bevelled, silvered, and graduated into degrees to serve as a goniometer. The carriage on which the object is placed rests on a piece of plate glass, kept down by a spring with an ivory-pointed screw to the two rails on the revolving stage platform, which gives an exceedingly smooth and firm movement, and a

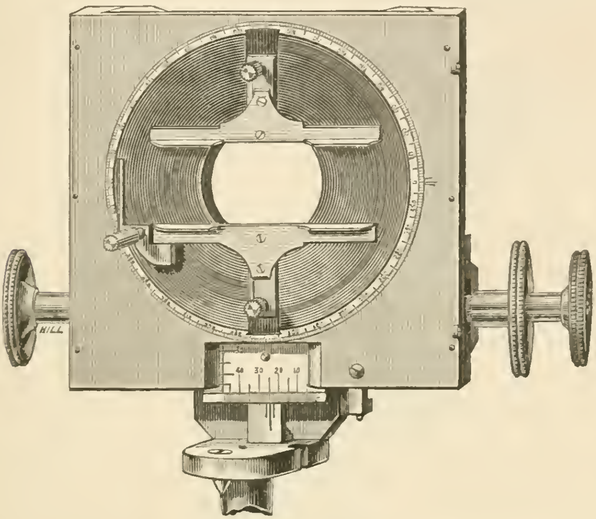
Fig. 134.




ZENTMAYER'S CENTENNIAL MICROSCOPE.

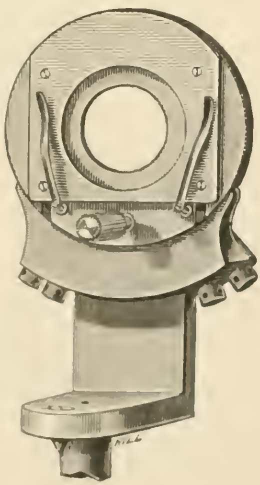
freedom of motion not obtained by any other arrangement. Owing to its simplicity, convenience, and durability, it has been extensively copied at home and abroad. The stage may be detached with facility,

FIG. 135.



by simply unscrewing the nut at the back of the bar, to be replaced by another stage, as, for instance, the Mechanical stage or the Diatom stage."

FIG. 136.

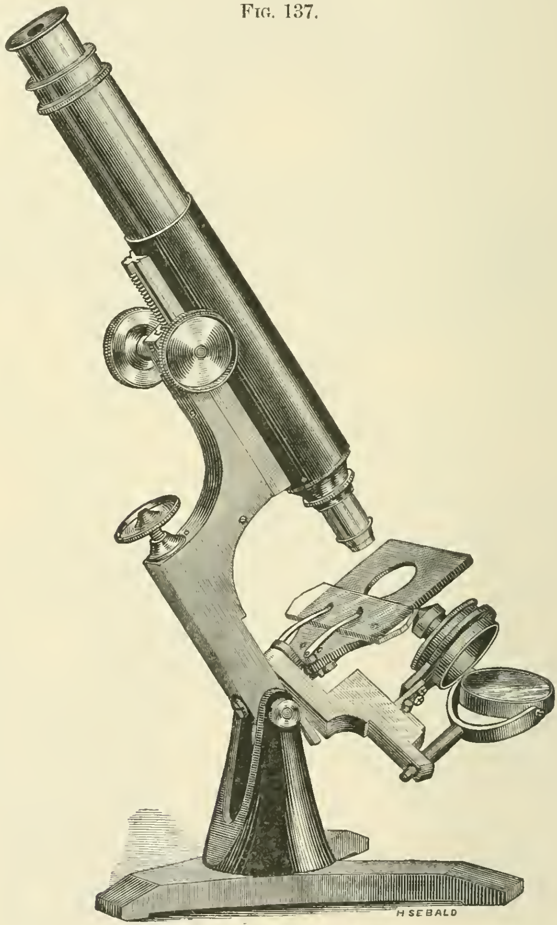


2nd. The Mechanical stage (Fig. 135, half-size) is 4 inches square and $\frac{3}{16}$ inch thick, with rectangular movements of 1 inch by the milled heads shown on the right and left. The forward motion of the stage is by means of a fine chain winding on a spindle beneath the stage acted on by the outer milled head, and is provided with a set-screw by which any stretching of the chain can be at once compensated. The cross-motion is effected by a travelling screw-socket attached beneath the stage, acted on by the inner milled head. These movements are extremely well constructed by Mr. Zentmayer. The graduated scales shown at the base serve as a finder.

The central circular plate (graduated at the margin) rotates in the plane of the stage, and is provided with two clips for the object. Inasmuch as this rotating centre-piece moves out of centre with every touch of the rectangular motions, the utility of the rotation is very much curtailed; a rotatory motion of the stage, unless it be approximately concentric with the optic axis, appears to us to be practically useless.

3rd. The Diatom stage (Fig. 136, half-size) is $2\frac{1}{2}$ inches in diameter and is bevelled out beneath, so that its thickness is only $\frac{1}{30}$ inch at

Fig. 137.




the centre. The lower plate rotates in the ring of the stage, and the upper one can be slipped backwards and forwards (beneath the spring clips) in two grooves. The four adjusting screws for centering are shown in the figure. Owing to its small size, it is very solid; it is especially convenient in that the swinging substage can be moved almost to the horizon of the object.

All of the stages are reversible on the stand, thus admitting of unlimited obliquity, and still keeping the object in the centre of the swinging bar.

(2) *Histological.*—This, constructed in 1876 (Fig. 137), shows the adaptation of the swinging substage to a cheap form of Microscope, and was earlier in date to that which we recently described at p. 532 as being the first cheap form that we had seen.

Mr. Zentmayer also constructed two other forms intermediate between this and the Centennial (" U.S. Army Hospital stands ").

**Bulloch's Congress and Biological Microscopes.** — (1) *Congress (older form).*—In 1877 the form shown in $\frac{1}{3}$ scale in Figs. 138 and 139 (19 inches high) was brought out (patented in 1879).

The figures render any detailed description of the parts of the instruments unnecessary, with the exception of the substage and mirror arrangements. These both move about the same centre, which is at a point the thickness of an ordinary slide above the stage, and they can be rotated by hand above and below the stage either *together*, when connected by the spring stop S (Fig. 138), or *separately* (as shown in Fig. 139).

The two arms (D D and O E) carrying the substage and the mirror are attached to the graduated circles shown in the figure, by which the exact degree of obliquity can be registered.

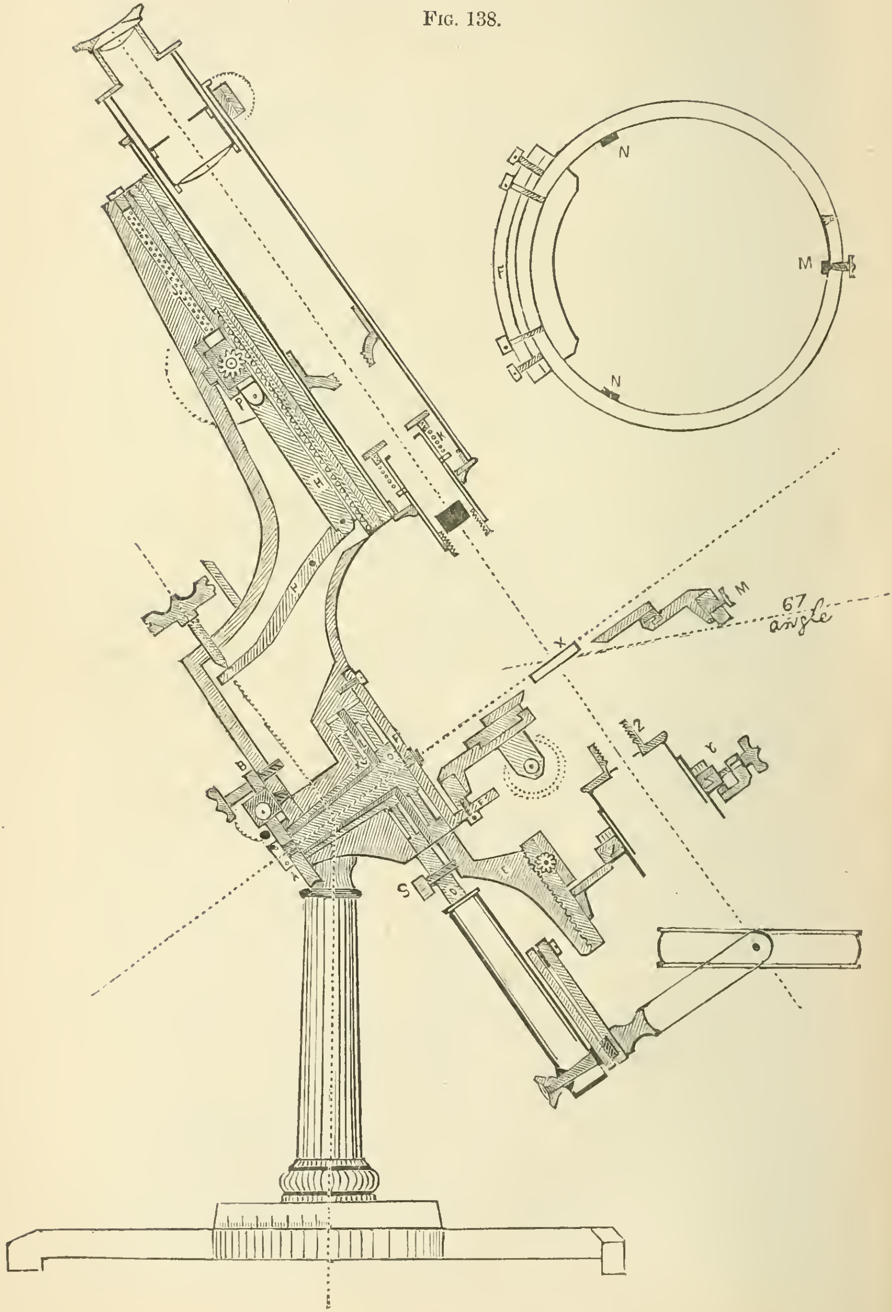
As originally constructed by Mr. Bulloch, the end of the substage pinion (passing through the limb) was provided with a toothed wheel A, upon which the tangent screw B acted, producing the lateral rotation of the substage bar. This mechanical rotation has since been replaced by friction motion that can be clamped by the milled head shown on Fig. 140 in the place of A in Fig. 138.

When placed horizontally as for drawing, every part moves accurately about the same centre X (in direct line with the object on the stage).

The fine adjustment is on the Franco-German principle, and moves the entire body without changing the distance between the objective and the eye-piece. The levers H H act directly upon the sliding-box which contains the pinion of the coarse adjustment, and this is in turn pressed down by a strong spiral spring J above it. In addition (which is important with this form of fine adjustment) the Society screw at the end of the body is arranged as a safety nose-piece K with spring. The arrangement of this form of fine adjustment differs from that of Mr. Zentmayer, as the latter uses an independent slide for the coarse and for the fine adjustment, and not one slide for both.

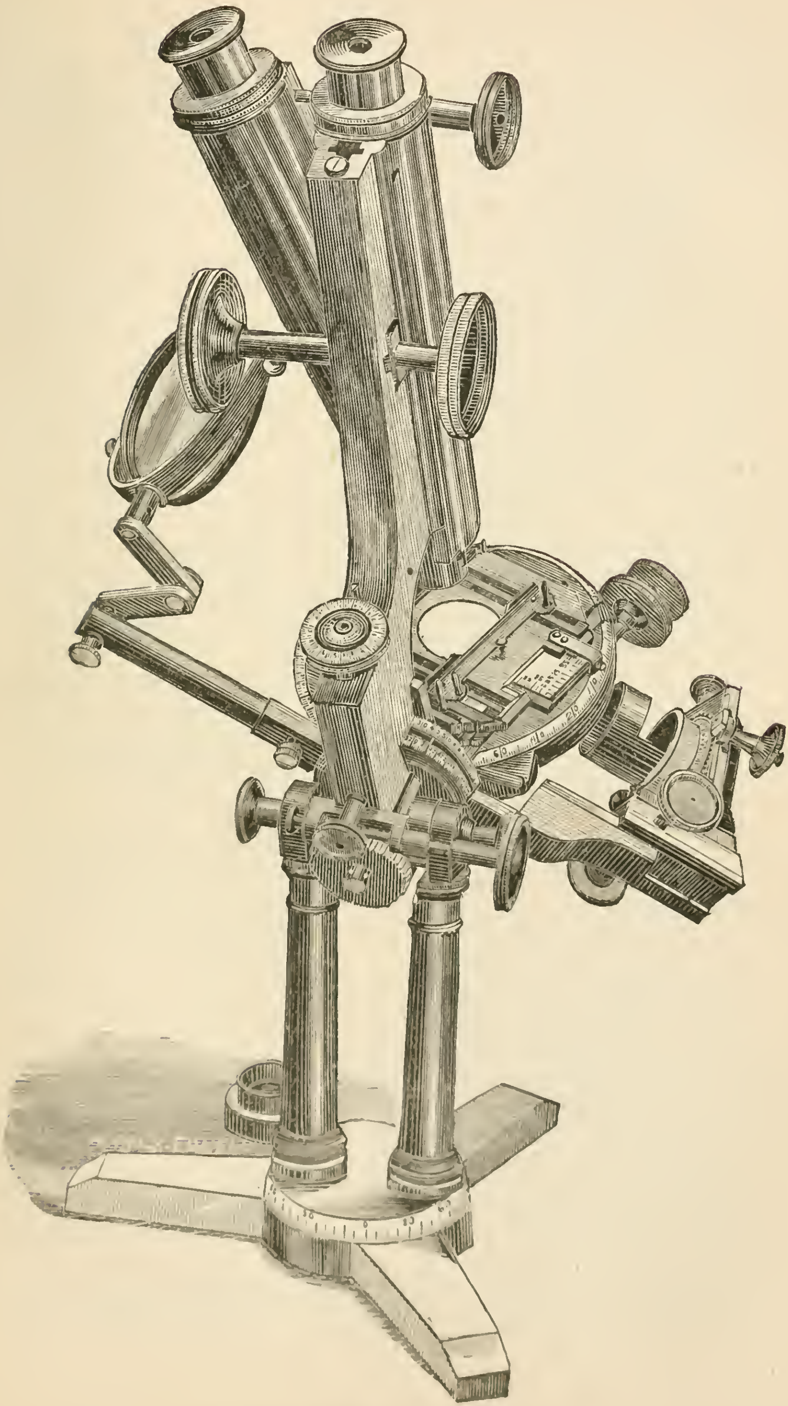
Heretofore in centering the stage to the optical axis it has been done by a ring within another one, in which the screws operate either to draw or push the interior ring into position. By this method the stage, in order to use it for oblique light, has to be made unnecessarily large. In place of a complete ring, Mr. Bulloch therefore uses a segment or " saddle piece," to which the stage-ring is attached. The arrangement is shown in the upper section of Fig. 138, where F is the saddle-piece, with the four centering screws passing through

Fig. 138.




BULLOCH'S CONGRESS MICROSCOPE (OLDER FORM).

FIG. 139.



BULLOCH'S CONGRESS MICROSCOPE (OLDER FORM).

it, being firmly fastened to the limb. The ring may be clamped in any position by a screw passing through the base of F, and the stage may be clamped in any position by M. The projections at N (and M) afford bearings for the stage to move upon and diminish friction.

The stage is thin enough to admit oblique light up to 134°.

(2) *Congress* (*newer form*).—Mr. Bulloch writes: "I have recently made several improvements and additions to the stand.

"As originally intended, the front end of the centre of the substage passed through and supported the stage support or saddle-piece; but for the finer work of measuring angles of aperture as Dr. Blackham does, any connection between substage and stage would cause the object to move to one side when the substage was swung from one side to the other; as now made there is no connection between substage or mirror and the stage; the stage is fixed to the limb by an angle-piece quite independent of the swinging arms, which I consider an important improvement. (Cf. Figs. 140 and 141.)

"I have also improved the arrangement of the pinion box; the slide of the coarse adjustment is now provided with a V piece on each side of the rack-work, and these fit into corresponding slots: they act as guides to the movement and add to the steadiness. I have also added guide pieces outside the pinion box, that travel with the fine adjustment on the sides of the limb. (Cf. Figs. 140 and 141: they are shown above and below the large milled heads on the limb.)

"In the end of the tube is the new broad-gauge screw (the 'Dr. Butterfield broad-gauge screw'), $1\frac{1}{4}$ inch in diameter, for low-power objectives of extra high angle. In this screw are two separate nose-pieces containing the Society screw—one is for the binocular, which must have diaphragms, so that the full benefit of high angle is lost; the other has a clear aperture, the diameter of the Society screw.

"At the upper end of the slide of the tube is a scale reading to $\frac{1}{100}$ of an inch, and the slow-motion screw reads to $\frac{1}{1000}$, so that working distance of objective can be measured.

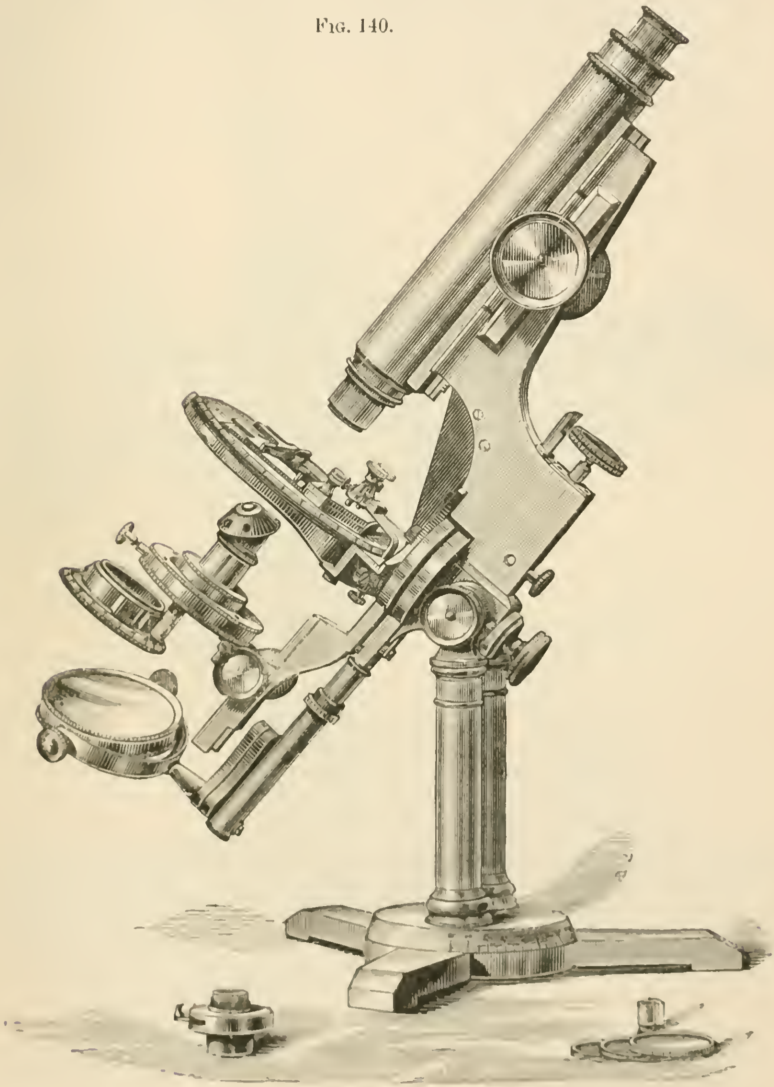
"There is also what I call a new adaptation of the Gillett diaphragm, which can be used close up to the object, or when using the hemispherical lens can be swung close round it. The Woodward prism and also the hemispherical lens are specially fitted to the under part of the stage support, so that the stage can be revolved in the axis without altering the position of the hemisphere."

Of the points mentioned in Mr. Bulloch's letter, we must certainly agree with him as to the importance of making the attachment of the stage substantial and rigid, as may doubtless be done by screwing it to the limb by an angle-piece. If it were desired to have a second stage adapted—say a small diatom stage—it would be quite possible to provide convenient means for changing the stage, and at the same time to ensure that either stage should, when in position, be exactly at right angles to the optic axis.

Still later Mr. Bulloch has modified the stand to make it more especially applicable for the examination of diatoms. The stand is shown in Figs. 140 and 141, the latter being a representation of the instrument in a horizontal position (with the lamp attached to the substage bar) for drawing, measuring apertures, &c.

Mr. Bulloch claims to have improved the construction of the

Fig. 140.

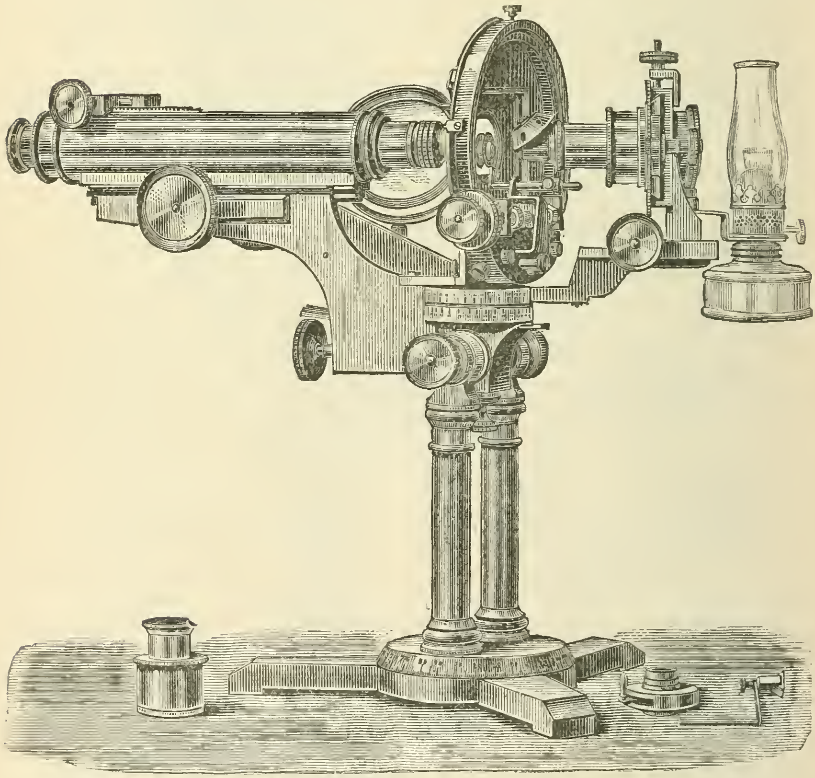


sliding glass stage; as previously made, there was always a liability to a sudden slipping of the stage if the Microscope were accidentally jarred. By using two pressure points fitted on one bar that turns on a swivel joint, the swivel accommodates for any difference of length in the points and thus equalizes the pressure and prevents slipping. The stage is thin enough to admit an angle of 160 degrees.

The substage is made in two parts, intended for the examination of polarizing objects when using an achromatic condenser. The lower part has a motion to one side, which leaves the condenser and light from the mirror in the same position. Fig. 140 shows the lower part swung out.

The Gillett diaphragm to the condenser—placed *above the lenses*—

FIG. 141.



is also shown, and a convenient plan for mounting a hemispherical lens for immersion illumination attached to an elbow-piece beneath the stage.

(3) *Biological.*—This (Fig. 142) is a smaller and more recent instrument (patented in 1879).

The substage and mirror can be moved independently round the focal point as a centre, and can be used above the stage if required.

They can also be clamped in any position by the milled head shown behind the limb.

The stage (with revolving concentric movement) is adjustable to the axis, measures 3½ inches in diameter, and is 3½ inches above the

Fig. 142.

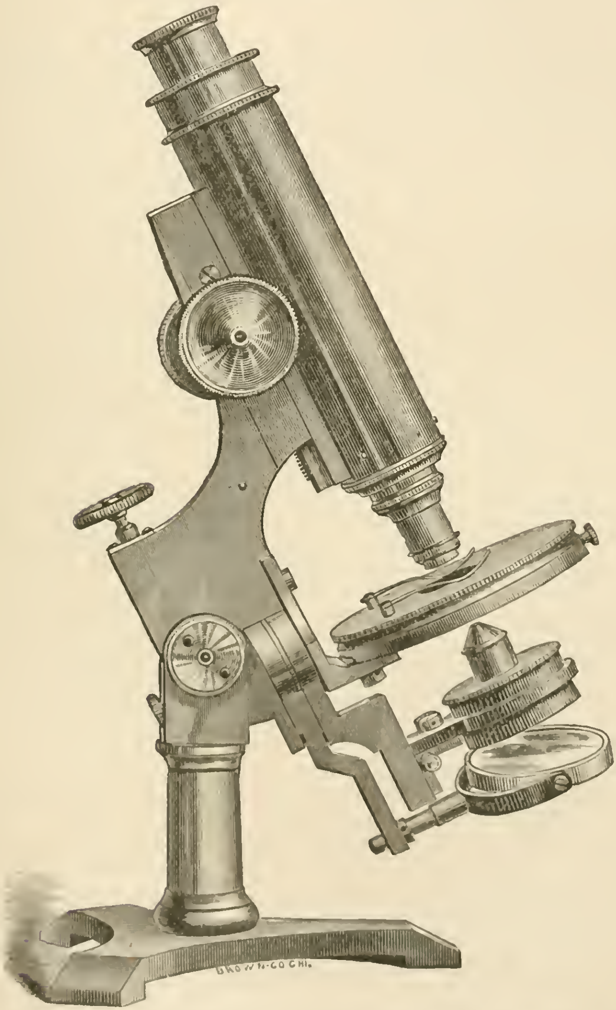


table. When not required to revolve, it can be clamped in any position by the milled head shown in front. When there is any danger of injuring the stage by the use of acids, it can be lifted out of the ring in which it revolves, and an ordinary piece of glass used on the top of the ring when the instrument is upright. The stand is 12½ inches in height, and the body and draw-tube are each 5 inches in length. The fine adjustment moves the whole body-tube, and there is the broad-gauge screw for high-angle low-power objectives, in which fits an adapter with the regular Society screw.

Other details are shown in the figure, which is about two-fifths the actual size of the instrument.

**Standards of Length—Illumination for Opaque Objects.***— Professor W. A. Rogers has published an exhaustive paper on those standards of length which are in actual use, and which have the authority and sanction of either national or international law. Much of the paper is beyond our scope; but the author refers to two points bearing upon the use of the Microscope in verifying standards.

With regard to the magnifying power of the Microscope employed, which is best adapted to secure the greatest absolute accuracy in measurements, the result of the author's experience on the subject is favourable to high powers. With a proper illumination, and with lines having smooth edges, a power of 900 can be used with great ease, even in the comparison of two metres upon a longitudinal comparator. In all the earlier comparisons Microscopes of very low power were employed, varying from 40 to 60 diameters, and the International Commission have decided upon the low power of 40 to 50. M. Tresca, of the French section, however, is a firm believer in high powers, and prefers one of about 400.

On the best method of illumination for opaque objects, Professor Rogers says—"I cannot better illustrate the necessity for a proper illumination in making exact measurements than by saying that I have been obliged to reject a series of observations, extending over a period of four months, for the simple reason that I finally discovered that, during all this time, I have never once seen the actual lines ruled, but only their image. I used a parabolic reflector, giving a beautiful *white* line on a black background. The lines were traced upon a steel surface, nickel-plated, their width being about one ten-thousandth of an inch. Investigation showed that the positions of the lines could be changed by an amount more than half their width, by shifting the position of the parabolic reflector.

The method of illumination employed by Baily and Sheepshanks seems to me radically defective. With the Microscopes used by Sheepshanks I found myself unable to separate lines ruled on a polished steel plate, though separated by an interval of only one-thousandth of a centimetre. As already stated, I have used with great satisfaction the form of illumination described by Mr. Tolles in the 'Annual of Scientific Discovery' for 1866-67.† It is sufficient to say here, that, as none of the light is lost by the reflection, it is easy to get all, and even more than is needed. Diffused daylight falling upon the plane face of the prism inserted between the two front lenses affords an abundance of light for the most delicate tracings. With a 1-inch objec-

* 'Proc. Am. Acad. Arts and Sci.,' xv. (1880) pp. 273-312.

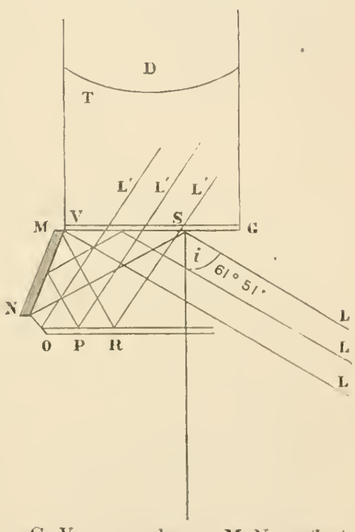
† See this Journal, *ante*, p. 754.

tive of the form recently constructed by Mr. Tolles, lines 30,000 to the inch, ruled on a polished steel surface, are resolved with the greatest ease."

Professor Rogers also refers to a "comparator" which he has designed as an improvement upon that described at p. 947 of vol. ii., a description of which we defer until a detailed account, with a drawing, has appeared.

**Mirror for Illuminating Opaque Objects for the Projecting Microscope.***—The subject of this note, by Mr. P. Frazer, jun., (which we give verbatim) "is an arrangement for representing opaque objects through the gas Microscope, especially adapted to Zentmayer's $1\frac{1}{2}$-inch objective. It is only claimed to be better than the parabolic reflector of Smith and Beck, J. Lawrence Smith, Sorby, and others, where the working distance of the Microscope is comparatively large (i. e. the distance from the objective to the object on the stage is $\frac{1}{2}$ inch or more) and for the purposes mentioned. Where the distance is as great as that just mentioned, the dispersion of rays from the reflection at one point, of rays from very different parts of the mirror, is so great that only a few rays from the upper part of the mirror reach the lens at all. It would be different with a lens having a very small working distance, and in this case a parabolic reflector would be preferable.

Fig. 143.




G V, cover-glass. M N, reflecting mirror. O P R, reflection on object. L′, rays which pass through the objective. D, lens. T, sliding tube carrying reflecting mirror. Angle of incidence 62°.

The apparatus consists of a brass tube made to slide over the lens, on the lower end of which is fixed a glass plate about 1 mm. in thickness, so attached as to be capable of a sliding motion towards or away from the hinged mirror which is attached to the edge of the metal flange in which the glass plate slides. This simple contrivance permits the glass plate to be brought into close contact with the reflecting mirror, no matter at what angle the latter may be placed.

The mirror is made of nickel-plated German silver neatly mounted on a small hinge.

The light is admitted from below through a diaphragm after the rays have been rendered parallel by the condenser of the lantern, the

* 'Proc. Am. Phil. Soc. Phila.,' xviii. (1880) p. 503.

aperture of the diaphragm being adapted to the maximum thickness of beam which can be effective for illumination, and which (calling $a$ the aperture of the lens and $i$ the angle of incidence of the beam) $= a$ cos. $i$; or for an aperture of $\frac{7}{8}$ inch ($= 0 \cdot 875$ inch) and an incident angle of 62°, 0·411 inch, or roughly 0·4 inch.

The less the incident angle, of course the larger the beam of light will be, and the greater the diameter of the diaphragm. The refractive index of the glass employed to make the plate being 1·5, in order that the critical angle 41° 48′ may not be exceeded in the refracted ray, this angle of incidence or $i$ must not be less than 61° 51′, or roughly 62°.

This minimum value of $i$ determines the area of surface which can be illuminated on the Microscope stage, but by altering the angle of the mirror very slightly, all parts of the object may be successively projected on the screen. This minimum value is easily obtained from the critical angle of the glass employed, which is 41° 48′. The complement of this, or 48° 12′, is equal to the angle of refraction (or $r$) when the minimum value of $i$ is attained.

$$\frac{\sin. i}{\sin. r} = 1 \cdot 5,$$
$$\sin. i = 1 \cdot 5 \, (\sin. 48^\circ \, 12'),$$
$$i = 61^\circ \, 51'.$$

In other words, the angle between the luminous ray and the glass plate can never exceed 28° 09′, or in round numbers 28°."

**Ebonite in Microscopical Appliances.**—In America ebonite has been adopted for some years for mounting eye-pieces, and for stages of laboratory Microscopes, principally by the Bausch and Lomb Optical Company, who claim for it special adaptability for these purposes as well as economy. M. Vérick, of Paris, has also used it for the diagonal sliding-boxes containing the prisms of his binocular eye-piece and the outer plates into which they fit, and it has also been adopted for rings for cells.

We are glad to see that ebonite is coming into use in this country, having been adopted for Stephenson's safety-stage* (by Mr. Teesdale), and now for Botterill's life trough.† There are many other pieces of apparatus for which the use of ebonite would be a great advantage in reducing weight.

* See this Journal, *ante*, p. 332. † Ibid., p. 148.

# PROCEEDINGS OF THE SOCIETY.

Meeting of 13th October, 1880, at King's College, Strand, W.C., The President (Dr. Beale, F.R.S.) in the Chair.

The Minutes of the meeting of 9th June last were read and confirmed, and were signed by the Chairman.

The List of Donations (exclusive of exchanges and reprints) received since the last meeting was submitted, and the thanks of the Society given to the donors.

| | From |
|---|---|
| Blackham, G. E.—On Angular Aperture of Objectives for the Microscope. 21 pp. and 18 plates. (8vo. New York, 1880.) | *The Author.* |
| Braithwaite, R.—The Sphagnaceæ or Peat Mosses of Europe and North America. 91 pp. and 29 plates. (8vo. London, 1880.) | *Ditto.* |
| Cunningham, D. D.—On certain effects of Starvation on Vegetable and Animal Tissues. 47 pp. and 11 figs. (4to. Calcutta, 1879.) | *Ditto.* |
| Lewis, T. R.—The Microscopic Organisms found in the Blood of Man and Animals, and their relation to Disease. 91 pp. and 3 plates and 27 figs. (4to. Calcutta, 1879.) | *Ditto.* |
| Mandl, L.—Anatomie Microscopique. 2 vols. pp. 368, 92 and 54, 412 and 40. Plates 52 and 40. (Fol. Paris, 1838–47, 1848–57.) | *Dr. Carpenter, C.B.* |
| Ranvier, L.—Leçons d'Anatomie Générale sur le Système Musculaire. 466 pp. and 99 figs. (8vo. Paris, 1880) | *Mr. Crisp.* |
| Fungus? on Human Hair | *Mr. G. C. Morris.* |
| Section of Electric Organ of the Ray | *Dr. B. W. Richardson.* |
| Slide and Packets of the Llyn Arenig Bach Diatomaceous Deposit | *Dr. H. Stolterfoth.* |

The President called particular attention to the two volumes of 'Mandl's Microscopic Anatomy' presented to the Society by Dr. Carpenter (reading to the Meeting the letter which accompanied the donation), and moved a special vote of thanks to Dr. Carpenter, which was carried unanimously.

Mr. Crisp exhibited and described Waechter's Demonstrating Microscope and Wasserlein's Saccharimeter-Microscope, and exhibited Professor Huxley's Dissecting Microscope (see p. 705), Teschner's Trichina-Microscope (see p. 715), the two shown at pp. 882 and 883 (Figs. 97 and 98), and another of Waechter's, with fine adjustment on the same plan as Seibert and Krafft's, Figs. 99 and 100, p. 883.

Mr. Swift exhibited and described a Microscope with radial traversing substage illuminator (see p. 867).

Mr. Crisp pointed out that the speciality of the instrument consisted, 1st, in its having *two* sectors at right angles; 2nd, in the reduced size of the condensers; and 3rd, in the sectors being removable, so that they could be replaced by the ordinary substage if desired.

---

**Mr. Jno. Mayall, jun.**, exhibited "the Thury-Nachet Traverse Substage," one of the earliest forms of what was now called the "Swinging Substage" (made by M. Nachet in 1855 for M. Thury), and described the peculiarities of its construction (see p. 1059).

---

**Mr. Crisp** exhibited and described Messrs. Parkes's frog-plate (see p. 1041).

---

**Mr. Teesdale's** description of the Pearson-Teesdale microtome was read, and the instrument exhibited (see p. 1034).

---

**Mr. G. C. Morris's** letter as to what was supposed to be a fungus on human hair was read, together with a communication from Dr. Cooke, to whom the specimens had been submitted.

---

**Dr. Stolterfoth's** paper "On the Diatomaceæ in the Llyn Arenig Bach Deposit" (see p. 913) was read, and a slide in illustration exhibited. Several packets of the deposit referred to were also placed upon the table for distribution amongst the Fellows.

Dr. Matthews said that he visited the place some few years ago, and then found some pipe-clay works upon the spot. No one at that time thought that the deposit was diatomaceous earth, but pipe-clay, and it was used as such.

---

**Mr. Crisp** read some recent communications from Prof. Hamilton L. Smith, in which he recommended the abandonment of the wax cell (see p. 861), and the use of paper dipped in shellac varnish for making rings (see p. 1038).

Mr. James Smith said he had described these rings some fifteen years ago, and a notice of it appeared in the 'Transactions' at the time (see p. 1039).

Dr. Braithwaite said he had used them twenty-five years ago.

---

**Mr. Stewart** described the observations of M. Robin on a species of *Podophrya* (see p. 817), in connection with Mr. Badcock's paper on Acinetina (see p. 561), and drew figures in illustration on the board.

---

**Mr. A. A. Bragdon's** letter on fluid for homogeneous-immersion objectives was read (see p. 1051), and a discussion ensued, in the course of which

Mr. T. Powell said it was his decided opinion that such objectives were better constructed with a collar adjustment; if made so as to be at the right point when the collar was screwed home they could not go far wrong; and

Mr. Stephenson again reminded the Meeting that if the objects were in air and non-adherent to the cover, a homogeneous-immersion objective was no better than a water objective, as the aperture was at once cut down to the equivalent of 180° in air. The whole benefit of the oil-immersion was thus entirely lost.

---

**The following Objects, Apparatus, &c., were exhibited**:—

Mr. O. Brandt:—Slides of diatoms arranged by R. Getschmann.

Mr. Crisp:—The seven Microscopes mentioned on p. 1083.

" Parkes's frog plate (see p. 1041).

" Webb's finder (see p. 750).

Mr. J. Mayall, jun.:—The Thury-Nachet Traverse Substage (see p. 1059).

Mr. G. C. Morris:—Fungus (?) on human hair.

Dr. B. W. Richardson:—Section of electric organ of the Ray.

Dr. H. Stolterfoth:—Slide of the Llyn Arenig Bach Diatomaceous Deposit (see p. 913).

Mr. Swift:—Microscope with radial traversing substage illuminator (see p. 867).

Mr. Teesdale:—New (Pearson-Teesdale) microtome (see p. 1034).

---

**New Fellows**:—The following were elected *Ordinary Fellows*:—Messrs. Thomas Goodwin, J. Sibley Hicks, L.R.C.P., J. Buxton Payne, and J. C. Thompson; and *Ex-officio Fellow*:—The President for the time being of the Manchester Microscopical Society.

---

## Meeting of 10th November, 1880, at King's College, Strand, W.C. The President (Dr. Beale, F.R.S.) in the Chair.

**The Minutes** of the meeting of 13th October last were read and confirmed, and were signed by the President.

---

**The List of Donations** (exclusive of exchanges and reprints) received since the last meeting was submitted, and the thanks of the Society given to the donors.

| | From |
|---|---|
| Heurck, H. van.—Synopsis des Diatomées de Belgique. Fasc. I and II. Atlas. Plates 1–30. (8vo. Antwerp, 1880) | *The Author.* |
| Müller, N. J. C.—Handbuch der Botanik. 2er Band. 2er Theil. 482 pp. and 227 plates. (8vo. Heidelberg, 1880.) | *Mr. Crisp.* |
| Photographs of *Pleurosigma angulatum* and *Frustulia saxonica* | *Mr. O. Brandt.* |
| Santa Monica Earth, and Section and Photographs of the San Bernardino Meteorite | *Mr. H. G. Hanks.* |
| "Tripoli" from Richmond River, N. S. Wales | *Prof. A. Liversidge.* |

---

**Mr. O. Brandt's** letter as to the above photographs was read:—

"I enclose photographs of:—

1. *Pleurosigma angulatum* W. Smith, from a preparation of J. D. Möller, Wedel, magnified direct 2000 times with Gundlach's

No. VII. immersion and amplifier (concave lens). Distance 1 metre, central illumination.

2. *Pleurosigma angulatum*—the same frustule magnified direct 5900 times with Gundlach's No. VII. immersion and amplifier. Distance 3 metres, central illumination.

3. *Frustulia saxonica*, showing lines parallel to the axis of the frustule, magnified direct 5000 times with Seibert and Krafft's new oil-immersion objective.

The existence of these lines parallel to the axis of the diatom is quite new, and I think many of the Fellows will be interested to hear of it. It seems as if all drawings on all diatoms come back to crossed lines or circles, and as soon as one sort of lines can be seen the existence of others crossing the same can be guessed.

We are now trying to find these crossed lines in *Amphipleura pellucida*.

All the photographs were made by Carl Günther, of Berlin."

Mr. Jno. Mayall, jun., said it was very interesting to compare the lithographs published in the 'Monthly Microscopical Journal' (1876) of Dr. Woodward's photographs of *Frustulia saxonica* with those now shown. Dr. Woodward was at first doubtful as to the existence of both transverse and longitudinal lines, but Mr. Samuel Wells, of Boston, afterwards showed them very distinctly, though not so well as they were shown in the photographs before the meeting.

---

**Professor R. Hitchcock**'s letter was read as to the publication of Mr. Habirshaw's 'Catalogue of the Diatomaceæ' if a sufficient number of subscribers were obtained.

---

**Mr. Crisp** exhibited and described the following nine Microscopes:—Beck's Silk Mercer's, Swift's ditto, Holmes's Demonstrating, Nachet's "Snuff Box," Parkes's English Medical with sliding adapters for the objectives (see p. 1048), and a small form of simple Microscope with a mirror made in Paris. He also exhibited a Nachet Microscope to which the "Thury-Nachet Traverse Substage" (see p. 1059) had been attached, Sidle and Poalk's Acme Microscope with Iris Diaphragm (see pp. 532 and 1053), and the Tolles-Blackham Microscope (see p. 520).

---

**Dr. W. B. Carpenter, C.B.**, exhibited and described the "Working Microscope" devised by Mr. George Wale, an American manufacturer (see p. 1045). Being struck by the novelty of several parts of the instrument, he had thought it worth while to get one, and he had no hesitation in saying, after working with it, that it combined more good points than any student's Microscope which he had yet seen.

The first point was the method of suspension, which, instead of being on the usual plan of a swinging centre with two pivots, consisted of a grooved arc moving between corresponding curved fillets on a central support; the foot was of cast iron (together with the arc carrying the body), and was made in two pieces, on each of which a projecting fillet was cast, and which on being put together allowed the arc to freely move between them, a brass set-screw enabling it to be clamped rigidly in any desired position. In this way the Microscope was well supported without any tendency to tilt in any position. The next point was the fine adjustment, which was made upon a plan which he believed was Mr. Zentmayer's, but it was one which made it impossible for there to be any twist. The third point was in having the draw tube so made as to take an objective of much longer focus than usual; it was fitted with the Society's screw, and would also take an amplifier if needed.

The stage was simply a round plate of brass, but the method in which the fork for holding the object was fitted to the stage gave it almost the advantage of a revolving stage. The mode in which the mirror was hung was also very satisfactory in a student's Microscope, admitting as it did of being swung laterally in either direction, and also—by means of a slide in the bar on which it was mounted—of being moved up near to the objective so as to act as a condenser. There was also an addition to the Microscope of great value, viz. an iris diaphragm (see p. 1052) of very simple and ingenious construction (described and figured on the black board).

Altogether the instrument was one which much pleased him, and he had brought it under their notice in the hope that some of its points might be taken up in this country, where the demand for efficient student's Microscopes of good quality was becoming so great that it would be worth while for any maker to bring out the best that could be produced at a moderate cost. This Microscope could be supplied in New York at about 7*l.*, but he thought it quite probable that it might be made here for say 1*l.* less.

The President expressed the thanks of the meeting to Dr. Carpenter for his explanation.

Dr. Edmunds pointed out that this most useful microscope-stand would be vastly improved if only the arc upon which the body turns were so constructed that the centre of the circle of which the arc forms part were made to coincide in position with the centre of the stage. The object then would undergo no movement of translation, either in rotating the stage or in turning the optical tube from the vertical to the horizontal. In rotating the stage, the object would turn upon the optic axis; in moving the tube into various degrees of obliquity from 0° to 90°, the object would rotate upon its horizontal axis. The result would be that, with a thin stage and a hemispherical lens in immersion contact with the under surface of the slide, all the complicated swinging substages and other contrivances now upon the table might be swept away, and every angle of illumination could be got by merely inclining the body of the Microscope upon its sustaining arc. There would only be needed a lamp on a level with the object with a condenser at its focal distance standing upon the table in line between the lamp and the object.

Dr. Carpenter said that another improvement had also occurred to him, and that was to construct the fork so that it would carry round the object in the axis of the Microscope. It did not do so as at present constructed, but might easily be made to do so, and thus to answer the purpose of a rotating stage.

---

**Mr. John Mayall, jun.**, described the Tolles-Blackham Microscope, exhibited by Mr. Crisp (see p. 520), and described and exhibited Hyde's Illuminator, which had been devised to produce a luminous field similar to that obtained by Mr. Wenham's reflex illuminator.

---

**Mr. Crisp** called attention to several new applications of ebonite to microscopical purposes, including "Botterill's Life Trough" (see p. 148), now made in ebonite, Atwood's rubber-cell (see p. 1041), and Beck's rotating holder for the latter.

---

**Mr. Swift** exhibited and explained by means of a diagram a form of ("calotte") diaphragm which he had devised for bringing a series of apertures immediately below the object (see p. 1053).

---

**Mr. W. G. Lettsom** described Professor Abbe's new form of binocular eye-piece ("Stereoscopic Ocular") specially adapted for the short-bodied instruments in ordinary use on the Continent, illustrating it by a diagram drawn upon the black board, and by the exhibition of the instrument in the room.

Mr. Crisp exhibited for comparison three other forms of binocular eye-pieces, viz. those of Prazmowski, Tolles, and Vérick.

Dr. Carpenter said he should like to say a few words about the arrangement of Professor Abbe. He had paid a great deal of attention to the subject of binocular vision, and might say that he had been at the birth of the binocular Microscope. As regarded the one now exhibited, it seemed to him to have been overlooked that in order to get a true stereoscopic projection the rays from one side of the objective must cross completely over to the opposite side of the instrument. This was done in Nachet's and in Wenham's, and with either of these it was impossible to see an object in any other way than stereoscopically. To produce this effect it was necessary that the lateral inversion should be antagonized by the reflecting power of the prism—they must have the reflected ray crossing the other entirely, otherwise they could not have any true stereoscopic effect.

Another observation which he had to make was that the arrangement now described resembled Mr. Wenham's arrangement for a *non*-stereoscopic binocular. In this form Mr. Wenham made his two prisms in the same way, and except that they were in contact the thing was the same; it was devised for the purpose of diminishing the fatigue of working with one eye so as to give a more comfortable view of an object in case of prolonged observation, and this was described and figured in the 'Transactions' of the Society for 1866 (N. S. xiv. pp. 103–6, 3 figs.). In the true stereoscopic binocular the pencil of light was split into two halves, and in Mr. Wenham's standard form one lateral half went into the principal body and the other was reflected obliquely into the secondary body. But this new form did not do so, neither did that of Messrs. Powell and Lealand—indeed they did not pretend that it did. He had, therefore, no hesitation in saying that any stereoscopic effect in such an instrument must be formed entirely in the imagination of the observer, just as a seal might be seen under certain conditions, and might be imagined to be either a sunk impression or a raised cameo; for when one had got a conception of solidity, this mental conception might easily be carried on.

He had found the binocular to be essential to a knowledge of solid form, and as he had often expressed that opinion, a number of foreign microscopists had from time to time come to him upon the subject. One day Professor Haeckel, amongst others, seemed, as most continental observers used to be, rather doubtful as to the value of the binocular. He showed him at first some Polycistina, which were of course familiar to him as solid objects, and he looked at them and said he did not see them differently from usual. Then he showed him an object which he had not seen before—it was a piece of the wing of a small moth, which had a peculiar arrangement of the scales. Drawing out the prism, he asked the professor to look at the object and to adjust the focus so as to get a good middle distance, and then whilst he was looking at it the prism was suddenly replaced. He quite started at the result, for he then saw the undulations as if they were a solid raised surface, and admitted at once the true character of the stereoscopic effect produced. The mere fact that altering the caps as described by Mr. Lettsom was stated to be competent to change the image from stereoscopic to pseudoscopic satisfied him at once that there was no true stereoscopic effect produced.

---

**Mr. Crisp** referred to several communications upon the subject of wax cells, American correspondents more particularly being of opinion that Professor Hamilton Smith had given them up too hastily, and that the sweating complained of came from the use of cements containing turpentine, &c., and other causes apart from the wax (see p. 1039).

---

**Mr. Shadbolt's** Memorandum on Apertures "exceeding 180° in Air" was read as follows:—

"It was with considerable regret that I found a short article in the October number of the 'Journal' (p. 875), entitled 'Apertures exceeding 180° in Air,' especially as it was not followed by any editorial comment of warning against the errors of both theory and fact involved therein.

In the article in question I find the following sentence, viz.:—'The whole confusion has arisen from not getting beyond the simple and obvious fact, about which there can be no dispute, that a *dry* lens cannot have an aperture of more than 180°.' To any one who cannot grasp this 'obvious fact,' I doubt that any explanation of optical phenomena would be intelligible. The statement is true, certainly; but it is also misleading, because it is only a part of the truth. The whole confusion has arisen from not getting beyond the simple and obvious fact—about which there can be no dispute, that *no lens, dry or immersion*, can possibly have an aperture of 180°.

I presume that no one will dispute the fact, that two contiguous points in any object must be in a straight line, and that three points contiguous to one another lie in a plane, consequently that if the bundle of light-rays radiant from *each* point reached 180°—one of such rays at least must pass *clean through the adjacent point;* and this is equally true, whether the object is in air, or immersed in water, oil, balsam, or any other transparent medium. The difference is infinitesimal; but less than 180° it must be. Again, I presume that no one will contend that it is possible to collect from any given point a larger number of light-rays than are actually emitted from that point, and if so, my contention is established.

But I am by no means content to leave the matter here. A lens must have a surface of some kind, and it is quite impossible to bring the surface of a lens in *close contact* with the *whole* of even so small a part of the object as we wish to examine; and unless we can do this—nay, even if we could do this—we must leave out a further portion of the supposed pencil of 180° of radiant light; because, as the extreme rays would be *paralell* to the front surface of the lens, there would be no refraction.

I may add further, that were such a lens constructed that it could refract the largest possible portions of the 180° of radiant light, it would be practically useless, as there would be no working distance and no possible adjustment to suit varying sights. I state as a matter of *opinion* only, that I very much doubt whether we can hope to see any lens constructed to include practically, that is, efficiently, more than 170° of aperture. Let us suppose such a dry lens to have been constructed and placed in position to examine some transparent object simply laid upon a slip of glass, which object is illuminated from below; the lens would now receive and refract from each luminous point a pencil of 170°; but if that object were mounted in balsam, or other dense medium, and protected as usual with a thin covering of glass, the same dry objective could no longer refract the 170° radiant pencil of light, because certain of the rays of that pencil would, in their passage towards the lens, fall on the upper surface of the covering-glass, at and beyond the *critical angle*, and would therefore find no exit; the angular aperture of each pencil of rays proceeding from the object, would therefore be limited to an angle equal to double the *critical angle* for the covering-glass employed. I may remark, in passing, that this would not be the case were the object mounted dry and the two surfaces of the covering-glass parallel.

It now becomes apparent why an immersion objective can in suitable cases perform better than dry ones. With an appropriate fluid interposed the *critical angle* for glass becomes obliterated; and the pencil of rays, *whatever its aperture*, can pass direct to the posterior surface of the front lens, and there become refracted for effective use in forming an image; and this is where the immersion lens has the advantage; it can include as large a portion of the radiant pencils of light as the lens is constructed to admit, irrespective of the mounting of the object, but in no case can it reach, far less exceed, 180°.

It may be as well here to note, that with a dry lens, both the front and back surfaces of the front lens take part in the refractions; but with an immersion lens, the refraction at the front surface is suppressed or greatly reduced.

Before concluding, I wish to make a remark or two upon some of the statements in the article, and as it is anonymous, I trust I can do so without offence; my sole object being to resist the promulgation of erroneous views, and the use of vague and incorrect expressions in matters of scientific interest. What does the writer of the article mean by '*radiant spaces?*' How can 'diffraction *spectra*' pass through them? How can a 'space of 6°' become larger or smaller? It is to such expressions as these that confusion of ideas arises, far more than from any inability to grasp the fact that a lens cannot have an aperture of more than 180°."

Mr. Wilson said that Mr. Shadbolt appeared to have altogether misapprehended the note at p. 875. That did not refer to "*angle*" at all, but to "*aperture*," and it was now well established that they were not synonymous terms; he did not therefore follow Mr. Shadbolt's demonstration as to the angle being necessarily less than 180°, which he imagined that no one disputed. The original note and Mr. Shadbolt's letter related in fact to two distinct matters.

Mr. Crisp said the note referred to would certainly not have been admitted into the 'Journal' if it had been inconsistent with Mr. Shadbolt's demonstration as to an angle of 180°. On receipt of his letter, he had written to Mr. Shadbolt, pointing out that the note referred to *aperture*, and had received a further letter, in which he said:—

"I cannot assent to the word 'aperture' as employed. The absolute 'aperture' of a telescopic lens is sufficiently intelligible, so is the 'angular aperture' of a microscopical lens, but an 'aperture' that is neither absolute nor angular is not intelligible at all, especially if you call it 'numerical *aperture*.' Now, if it had been called '*numerical resolving power*,' it would I fancy be nearer to what is really meant.

I am fully alive to the advantage of immersion lenses in *appropriate conditions*, but I altogether deny their universal applicability. There is no difficulty in getting the largest practicable pencil of light, say 170°, *into* a dry lens; the difficulty is, that you cannot get such a pencil *out* of the mounting of the object when in balsam, or similar medium, and that is bounded by a stratum of air.

This is very easily demonstrable by a few lines added to the diagram given by Professor Stokes, at p. 141, vol. i. of the present series. With a little modification this observation applies also to an object mounted dry, but covered with a thin film of glass.

Should there be any kind of discussion, kindly put forward these remarks in my absence."

Mr. Wilson said that Professor Stokes' paper was a refutation of the very fallacy on which Mr. Shadbolt's reasoning was based. The expression "angle of aperture" had never in fact been a measure of the relative apertures of even dry objectives, and on the introduction of immersion objectives it had ceased to have any definite meaning whatever.

---

**Dr. Maddox** exhibited and described a modification of his Aeroconiscope for collecting particles from the atmosphere.

---

**Mr. Crisp** explained the properties of monobromide of naphthaline proposed by Professor Abbe for mounting diatoms. Its refractive index was stated as 1·658, and its "index of visibility" (on Mr. Stephenson's theory) as double that of Canada balsam, or 22 when used on diatomaceous silex (see p. 1043).

Dr. Edmunds inquired if it was unchangeable.

Mr. Crisp said it did not seem to have been very long in use. It could be obtained in London.

---

**Dr. G. W. Royston-Pigott's** paper "On a new Method of Testing an Object-glass, used as a simultaneous Condensing Illuminator of brilliantly reflecting objects, such as minute particles of Quicksilver" (see p. 916), was, owing to the lateness of the hour, taken as read.

---

**Mr. Stewart's** paper, "On some Structural Features of *Echinostrephus molare*, *Parasalenia gratiosa*, and *Stomopneustes variolaris*" (see p. 909), was also taken as read.

---

**The following Objects, Apparatus, &c., were exhibited:—**

Mr. O. Brandt:—Photographs of *Pleurosigma angulatum* and *Frustulia saxonica*.

Dr. Carpenter:—Wale's Working Microscope and Iris Diaphragm.

Mr. Coppock:—Rotating Holders for Atwood's Rubber Cells.

Mr. Crisp:—The nine Microscopes mentioned on p. 1086; and Botterill's Life Trough in Ebonite.

Mr. H. G. Hanks:—Santa Monica Earth, and Section and Photographs of the San Bernardino Meteorite.

Mr. Lettsom:—Abbe's Binocular Eye-piece.

Prof. A. Liversidge:—"Tripoli" from Richmond River, N. S. W.

Mr. J. Mayall, junr.:—Hyde's Illuminator.

Dr. Maddox:—Modified Aeroconiscope.

Messrs. Powell and Lealand:—*Amphipleura pellucida* with $\frac{1}{12}$ homogeneous-immersion objective, and their modification of the vertical illuminator.

Mr. Stewart:—Various Echinoderms illustrating his paper.

Mr. Swift:—Microscope with "Calotte" Diaphragm.

---

**New Fellows.**—The following were elected *Ordinary Fellows*:—Sir Henry Cotterell, Bart., and Messrs. F. M. Balfour, M.A., F.R.S., John Henry Cooke, and Levison Edward Scarph, M.A.

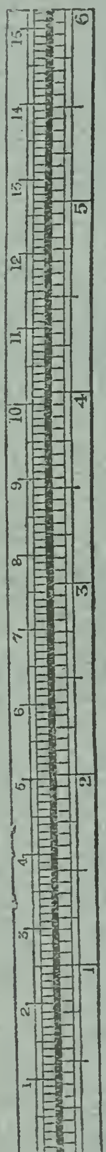
WALTER W. REEVES,
*Assist.-Secretary.*

## I. Conversion of British and Metric Measures.

### (1.) Lineal.

Scale of Inches, Centimetres, &c.

cm.
mm. ins.



1000 μ = 1 mm.
10 mm. = 1 cm.
10 cm. = 1 dm.
10 dm. = 1 metre.

*Inches, &c., into Micromillimetres, Millimetres, &c.*

| ins. | μ |
|---|---|
| $\frac{1}{25000}$ | 1·015991 |
| $\frac{1}{20000}$ | 1·269989 |
| $\frac{1}{15000}$ | 1·693318 |
| $\frac{1}{10000}$ | 2·539977 |
| $\frac{1}{9000}$ | 2·822197 |
| $\frac{1}{8000}$ | 3·174971 |
| $\frac{1}{7000}$ | 3·628539 |
| $\frac{1}{6000}$ | 4·233295 |
| $\frac{1}{5000}$ | 5·079954 |
| $\frac{1}{4000}$ | 6·349943 |
| $\frac{1}{3000}$ | 8·466591 |
| $\frac{1}{2000}$ | 12·699886 |
| $\frac{1}{1000}$ | 25·399772 |
| | mm. |
| $\frac{1}{900}$ | ·028222 |
| $\frac{1}{800}$ | ·031750 |
| $\frac{1}{700}$ | ·036285 |
| $\frac{1}{600}$ | ·042333 |
| $\frac{1}{500}$ | ·050800 |
| $\frac{1}{450}$ | ·056444 |
| $\frac{1}{400}$ | ·063499 |
| $\frac{1}{350}$ | ·072571 |
| $\frac{1}{300}$ | ·084666 |
| $\frac{1}{250}$ | ·101599 |
| $\frac{1}{200}$ | ·126999 |
| $\frac{1}{150}$ | ·169332 |
| $\frac{1}{100}$ | ·253998 |
| $\frac{1}{50}$ | ·507995 |
| $\frac{1}{25}$ | 1·015991 |
| $\frac{1}{20}$ | 1·269989 |
| $\frac{1}{16}$ | 1·587486 |
| $\frac{1}{15}$ | 1·693318 |
| $\frac{1}{12}$ | 2·116648 |
| $\frac{1}{10}$ | 2·539977 |
| $\frac{1}{8}$ | 3·174971 |
| $\frac{1}{6}$ | 4·233295 |
| $\frac{3}{16}$ | 4·762457 |
| $\frac{1}{5}$ | 5·079954 |
| $\frac{1}{4}$ | 6·349943 |
| $\frac{5}{16}$ | 7·937429 |
| $\frac{3}{8}$ | 9·524914 |
| $\frac{7}{16}$ | 11·112400 |
| $\frac{1}{2}$ | 12·699886 |
| $\frac{9}{16}$ | 14·287372 |
| $\frac{5}{8}$ | 15·874857 |
| $\frac{11}{16}$ | 17·462343 |
| $\frac{3}{4}$ | 19·049829 |
| $\frac{13}{16}$ | 20·637315 |
| $\frac{7}{8}$ | 22·224800 |
| $\frac{15}{16}$ | 23·812286 |
| 1 | 25·399772 |
| 2 | 50·799544 |
| 3 | 76·199316 |
| 4 | 101·599088 |
| 5 | 126·998860 |
| 6 | 152·398632 |
| 7 | 177·798404 |
| 8 | 203·198176 |
| 9 | 228·597948 |
| 10 | 253·997720 |
| 11 | 279·397492 |
| 1 ft. | 304·797264 |
| | metres. |
| = | ·304797 |
| 1 yd. = | ·914392 |

*Micromillimetres, Millimetres, &c., into Inches, &c.*

| μ | ins. |
|---|---|
| 1 | ·000039 |
| 2 | ·000079 |
| 3 | ·000118 |
| 4 | ·000157 |
| 5 | ·000197 |
| 6 | ·000236 |
| 7 | ·000276 |
| 8 | ·000315 |
| 9 | ·000354 |
| 10 | ·000394 |
| 11 | ·000433 |
| 12 | ·000472 |
| 13 | ·000512 |
| 14 | ·000551 |
| 15 | ·000591 |
| 16 | ·000630 |
| 17 | ·000669 |
| 18 | ·000709 |
| 19 | ·000748 |
| 20 | ·000787 |
| 21 | ·000827 |
| 22 | ·000866 |
| 23 | ·000906 |
| 24 | ·000945 |
| 25 | ·000984 |
| 26 | ·001024 |
| 27 | ·001063 |
| 28 | ·001102 |
| 29 | ·001142 |
| 30 | ·001181 |
| 31 | ·001220 |
| 32 | ·001260 |
| 33 | ·001299 |
| 34 | ·001339 |
| 35 | ·001378 |
| 36 | ·001417 |
| 37 | ·001457 |
| 38 | ·001496 |
| 39 | ·001535 |
| 40 | ·001575 |
| 41 | ·001614 |
| 42 | ·001654 |
| 43 | ·001693 |
| 44 | ·001732 |
| 45 | ·001772 |
| 46 | ·001811 |
| 47 | ·001850 |
| 48 | ·001890 |
| 49 | ·001929 |
| 50 | ·001969 |
| 60 | ·002362 |
| 70 | ·002756 |
| 80 | ·003150 |
| 90 | ·003543 |
| 100 | ·003937 |
| 200 | ·007874 |
| 300 | ·011811 |
| 400 | ·015748 |
| 500 | ·019685 |
| 600 | ·023622 |
| 700 | ·027559 |
| 800 | ·031496 |
| 900 | ·035433 |
| 1000 (=1 mm.) | |

| mm. | ins. | mm. | ins. |
|---|---|---|---|
| 1 | ·039370 | 51 | 2·007892 |
| 2 | ·078741 | 52 | 2·047262 |
| 3 | ·118111 | 53 | 2·086633 |
| 4 | ·157482 | 54 | 2·126003 |
| 5 | ·196852 | 55 | 2·165374 |
| 6 | ·236223 | 56 | 2·204744 |
| 7 | ·275593 | 57 | 2·244115 |
| 8 | ·314963 | 58 | 2·283485 |
| 9 | ·354334 | 59 | 2·322855 |
| 10 (1 cm.) | ·393704 | 60 (6 cm.) | 2·362226 |
| 11 | ·433075 | 61 | 2·401596 |
| 12 | ·472445 | 62 | 2·440967 |
| 13 | ·511816 | 63 | 2·480337 |
| 14 | ·551186 | 64 | 2·519708 |
| 15 | ·590556 | 65 | 2·559078 |
| 16 | ·629927 | 66 | 2·598448 |
| 17 | ·669297 | 67 | 2·637819 |
| 18 | ·708668 | 68 | 2·677189 |
| 19 | ·748038 | 69 | 2·716560 |
| 20 (2 cm.) | ·787409 | 70 (7 cm.) | 2·755930 |
| 21 | ·826779 | 71 | 2·795301 |
| 22 | ·866149 | 72 | 2·834671 |
| 23 | ·905520 | 73 | 2·874041 |
| 24 | ·944890 | 74 | 2·913412 |
| 25 | ·984261 | 75 | 2·952782 |
| 26 | ·023631 | 76 | 2·992153 |
| 27 | 1·063002 | 77 | 3·031523 |
| 28 | 1·102372 | 78 | 3·070894 |
| 29 | 1·141742 | 79 | 3·110264 |
| 30 (3 cm.) | 1·181113 | 80 (8 cm.) | 3·149634 |
| 31 | 1·220483 | 81 | 3·189005 |
| 32 | 1·259854 | 82 | 3·228375 |
| 33 | 1·299224 | 83 | 3·267746 |
| 34 | 1·338595 | 84 | 3·307116 |
| 35 | 1·377965 | 85 | 3·346487 |
| 36 | 1·417335 | 86 | 3·385857 |
| 37 | 1·456706 | 87 | 3·425227 |
| 38 | 1·496076 | 88 | 3·464598 |
| 39 | 1·535447 | 89 | 3·503968 |
| 40 (4 cm.) | 1·574817 | 90 (9 cm.) | 3·543339 |
| 41 | 1·614188 | 91 | 3·582709 |
| 42 | 1·653558 | 92 | 3·622080 |
| 43 | 1·692928 | 93 | 3·661450 |
| 44 | 1·732299 | 94 | 3·700820 |
| 45 | 1·771669 | 95 | 3·740191 |
| 46 | 1·811040 | 96 | 3·779561 |
| 47 | 1·850410 | 97 | 3·818932 |
| 48 | 1·889781 | 98 | 3·858302 |
| 49 | 1·929151 | 99 | 3·897673 |
| 50 (5 cm.) | 1·968521 | 100 (10 cm. = 1 decim.) | |

| decim. | ins. |
|---|---|
| 1 | 3·937043 |
| 2 | 7·874086 |
| 3 | 11·811129 |
| 4 | 15·748172 |
| 5 | 19·685215 |
| 6 | 23·622258 |
| 7 | 27·559301 |
| 8 | 31·496344 |
| 9 | 35·433387 |
| 10 (1 metre) | 39·370430 |
| | = 3·280869 ft. |
| | = 1·093623 yds. |

## II. Corresponding Degrees in the Fahrenheit and Centigrade Scales.

| Fahr. ° | Cent. ° | Cent. ° | Fahr. ° |
|---|---|---|---|
| 500 | 260·0 | 100 | 212·0 |
| 450 | 232·2 | 98 | 208·4 |
| 400 | 204·4 | 96 | 204·8 |
| 350 | 176·7 | 94 | 201·2 |
| 300 | 148·9 | 92 | 197·6 |
| 250 | 121·1 | 90 | 194·0 |
| 212 | 100·0 | 88 | 190·4 |
| 210 | 98·9 | 86 | 186·8 |
| 205 | 96·1 | 84 | 183·2 |
| 200 | 93·3 | 82 | 179·6 |
| 195 | 90·6 | 80 | 176·0 |
| 190 | 87·8 | 78 | 172·4 |
| 185 | 85·0 | 76 | 168·8 |
| 180 | 82·2 | 74 | 165·2 |
| 175 | 79·4 | 72 | 161·6 |
| 170 | 76·7 | 70 | 158·0 |
| 165 | 73·9 | 68 | 154·4 |
| 160 | 71·1 | 66 | 150·8 |
| 155 | 68·3 | 64 | 147·2 |
| 150 | 65·6 | 62 | 143·6 |
| 145 | 62·8 | 60 | 140·0 |
| 140 | 60·0 | 58 | 136·4 |
| 135 | 57·2 | 56 | 132·8 |
| 130 | 54·4 | 54 | 129·2 |
| 125 | 51·7 | 52 | 125·6 |
| 120 | 48·9 | 50 | 122·0 |
| 115 | 46·1 | 48 | 118·4 |
| 110 | 43·3 | 46 | 114·8 |
| 105 | 40·6 | 44 | 111·2 |
| 100 | 37·8 | 42 | 107·6 |
| 95 | 35·0 | 40 | 104·0 |
| 90 | 32·2 | 38 | 100·4 |
| 85 | 29·4 | 36 | 96·8 |
| 80 | 26·7 | 34 | 93·2 |
| 75 | 23·9 | 32 | 89·6 |
| 70 | 21·1 | 30 | 86·0 |
| 65 | 18·3 | 28 | 82·4 |
| 60 | 15·6 | 26 | 78·8 |
| 55 | 12·8 | 24 | 75·2 |
| 50 | 10·0 | 22 | 71·6 |
| 45 | 7·2 | 20 | 68·0 |
| 40 | 4·4 | 18 | 64·4 |
| 35 | 1·7 | 16 | 60·8 |
| 32 | 0·0 | 14 | 57·2 |
| 30 | − 1·1 | 12 | 53·6 |
| 25 | − 3·9 | 10 | 50·0 |
| 20 | − 6·7 | 8 | 46·4 |
| 15 | − 9·4 | 6 | 42·8 |
| 10 | −12·2 | 4 | 39·2 |
| 5 | −15·0 | 2 | 35·6 |
| 0 | −17·8 | 0 | 32·0 |
| − 5 | −20·6 | − 2 | 28·4 |
| − 10 | −23·3 | − 4 | 24·8 |
| − 15 | −26·1 | − 6 | 21·2 |
| − 20 | −28·9 | − 8 | 17·6 |
| − 25 | −31·7 | − 10 | 14·0 |
| − 30 | −34·4 | − 12 | 10·4 |
| − 35 | −37·2 | − 14 | 6·8 |
| − 40 | −40·0 | − 16 | 3·2 |
| − 45 | −42·8 | − 18 | − 0·4 |
| − 50 | −45·6 | − 20 | − 4·0 |

## III. Conversion of Numerical and Angular Aperture.

| Numerical Aperture. | Angle of Aperture of *Dry* Objectives. ($n = 1.$) | Angle of Aperture of *Water-Immersion* Objectives. ($n = 1·33.$) | Angle of Aperture of *Homogeneous Immersion* Objectives. ($n = 1·52.$) | Theoretical Resolving Power, in Lines to an Inch. ($\lambda = 0·5269\ \mu$ = line E.) |
|---|---|---|---|---|
| 1·52 | .. | .. | 180° 0′ | 146,528 |
| 1·50 | .. | .. | 161° 23′ | 144,600 |
| 1·48 | .. | .. | 153° 39′ | 142,672 |
| 1·46 | .. | .. | 147° 42′ | 140,744 |
| 1·44 | .. | .. | 142° 40′ | 138,816 |
| 1·42 | .. | .. | 138° 12′ | 136,888 |
| 1·40 | .. | .. | 134° 10′ | 134,960 |
| 1·38 | .. | .. | 130° 26′ | 133,032 |
| 1·36 | .. | .. | 126° 57′ | 131,104 |
| 1·34 | .. | .. | 123° 40′ | 129,176 |
| 1·33 | .. | 180° 0′ | 122° 6′ | 128,212 |
| 1·32 | .. | 165° 56′ | 120° 33′ | 127,248 |
| 1·30 | .. | 155° 38′ | 117° 34′ | 125,320 |
| 1·28 | .. | 148° 28′ | 114° 44′ | 123,392 |
| 1·26 | .. | 142° 39′ | 111° 59′ | 121,464 |
| 1·24 | .. | 137° 36′ | 109° 20′ | 119,536 |
| 1·22 | .. | 133° 4′ | 106° 45′ | 117,608 |
| 1·20 | .. | 128° 55′ | 104° 15′ | 115,680 |
| 1·18 | .. | 125° 3′ | 101° 50′ | 113,752 |
| 1·16 | .. | 121° 26′ | 99° 29′ | 111,824 |
| 1·14 | .. | 118° 00′ | 97° 11′ | 109,896 |
| 1·12 | .. | 114° 44′ | 94° 56′ | 107,968 |
| 1·10 | .. | 111° 36′ | 92° 43′ | 106,040 |
| 1·08 | .. | 108° 36′ | 90° 33′ | 104,112 |
| 1·06 | .. | 105° 42′ | 88° 26′ | 102,184 |
| 1·04 | .. | 102° 53′ | 86° 21′ | 100,256 |
| 1·02 | .. | 100° 10′ | 84° 18′ | 98,328 |
| 1·0 | 180° 0′ | 97° 31′ | 82° 17′ | 96,400 |
| 0·98 | 157° 2′ | 94° 56′ | 80° 17′ | 94,472 |
| 0·96 | 147° 29′ | 92° 24′ | 78° 20′ | 92,544 |
| 0·94 | 140° 6′ | 89° 56′ | 76° 24′ | 90,616 |
| 0·92 | 133° 51′ | 87° 32′ | 74° 30′ | 88,688 |
| 0·90 | 128° 19′ | 85° 10′ | 72° 36′ | 86,760 |
| 0·88 | 123° 17′ | 82° 51′ | 70° 44′ | 84,832 |
| 0·86 | 118° 38′ | 80° 34′ | 68° 54′ | 82,904 |
| 0·84 | 114° 17′ | 78° 20′ | 67° 6′ | 80,976 |
| 0·82 | 110° 10′ | 76° 8′ | 65° 18′ | 79,048 |
| 0·80 | 106° 16′ | 73° 58′ | 63° 31′ | 77,120 |
| 0·78 | 102° 31′ | 71° 49′ | 61° 45′ | 75,192 |
| 0·76 | 98° 56′ | 69° 42′ | 60° 0′ | 73,264 |
| 0·74 | 95° 28′ | 67° 36′ | 58° 16′ | 71,336 |
| 0·72 | 92° 6′ | 65° 32′ | 56° 32′ | 69,408 |
| 0·70 | 88° 51′ | 63° 31′ | 54° 50′ | 67,480 |
| 0·68 | 85° 41′ | 61° 30′ | 53° 9′ | 65,552 |
| 0·66 | 82° 36′ | 59° 30′ | 51° 28′ | 63,624 |
| 0·64 | 79° 35′ | 57° 31′ | 49° 48′ | 61,696 |
| 0·62 | 76° 38′ | 55° 34′ | 48° 9′ | 59,768 |
| 0·60 | 73° 44′ | 53° 38′ | 46° 30′ | 57,840 |
| 0·58 | 70° 54′ | 51° 42′ | 44° 51′ | 55,912 |
| 0·56 | 68° 6′ | 49° 48′ | 43° 14′ | 53,984 |
| 0·54 | 65° 22′ | 47° 54′ | 41° 37′ | 52,056 |
| 0·52 | 62° 40′ | 46° 2′ | 40° 0′ | 50,128 |
| 0·50 | 60° 0′ | 44° 10′ | 38° 24′ | 48,200 |
| 0·48 | 57° 22′ | 42° 18′ | 36° 49′ | 46,272 |
| 0·46 | 54° 46′ | 40° 28′ | 35° 14′ | 44,344 |
| 0·44 | 52° 12′ | 38° 38′ | 33° 39′ | 42,416 |
| ·42 | 49° 40′ | 36° 49′ | 32° 5′ | 40,488 |
| ·40 | 47° 9′ | 35° 0′ | 30° 31′ | 38,560 |

## ADVERTISEMENTS FOR THE JOURNAL.

Mr. CHARLES BLENCOWE, of 75, Chancery Lane, W.C., is the authorized Agent and Collector for Advertising Accounts on behalf of the Society.

THE

# ROYAL MICROSCOPICAL SOCIETY.

(Founded in 1839. Incorporated by Royal Charter in 1866.)

**The Society** was established for the communication and discussion of observations and discoveries (1) tending to improvements in the construction and mode of application of the Microscope, or (2) relating to Biological or other subjects of Microscopical Research.

It consists of Ordinary, Honorary, and Ex-officio Fellows.

**Ordinary Fellows** are elected on a Certificate of Recommendation signed by three Fellows, stating the names, residence, description, &c., of the Candidate, of whom one of the proposers must have personal knowledge. The Certificate is read at a Monthly Meeting, and the Candidate balloted for at the succeeding Meeting.

The Annual Subscription is 2*l.* 2*s.*, payable in advance on election, and subsequently on 1st January annually, with an Entrance Fee of 2*l.* 2*s.* Future payments of the former may be compounded for at any time for 31*l.* 10*s.* Fellows elected at a meeting subsequent to that in June are only called upon for one-half of the year's subscription, and Fellows absent from the United Kingdom for a year, or permanently residing abroad, are exempt from one-half the subscription during absence.

**Honorary Fellows** (limited to 50), consisting of persons eminent in Biological or Microscopical Science, are elected on the recommendation of three Fellows and the approval of the Council.

**Ex-officio Fellows** (limited to 100) consist of the Presidents for the time being of such Societies at home and abroad as the Council may recommend and a Monthly Meeting approve. They are entitled to receive the Society's Publications, and to exercise all other privileges of Fellows, except voting, but are not required to pay any Entrance Fee or Annual Subscription.

**The Council**, by whom the affairs of the Society are managed, is elected annually, and is composed of the President, four Vice-Presidents, Treasurer, two Secretaries, and twelve other Fellows.

**The Meetings** are held on the second Wednesday in each month, from October to June, in the Society's Library at King's College, Strand, W.C. (commencing at 8 P.M.). Visitors are admitted by the introduction of Fellows.

In each Session two additional evenings ("Scientific Evenings") are devoted to the exhibition of Apparatus and Objects of novelty or interest relating to the Microscope or the subjects of Microscopical Research.

**The Journal**, containing the Transactions and Proceedings of the Society, with a Record of Current Researches relating to Invertebrata, Cryptogamia, Microscopy, &c., is published bi-monthly, and is forwarded *gratis* to all Ordinary and Ex-officio Fellows residing in countries within the Postal Union.

**The Library**, with the Instruments, Apparatus, and Cabinet of Objects, is open for the use of Fellows on Mondays, Tuesdays, Thursdays, and Fridays, from 11 A.M. to 4 P.M., and on Wednesdays from 7 to 10 P.M. It is closed during August.

*Forms of proposal for Fellowship, and any further information, may be obtained by application to the Secretaries, or Assistant-Secretary, at the Library of the Society, King's College, Strand, W.C.*